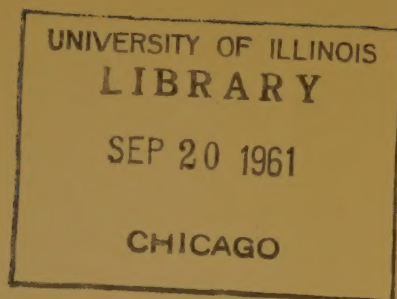


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NUCLEAR SCIENCE ABSTRACTS

Volume 15 Number 14

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July 31, 1961

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NUCLEAR SCIENCE ABSTRACTS

GENERAL AND MISCELLANEOUS

17876 (BMI-1496) PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING JANUARY, 1961. Russell W. Dayton and Clyde R. Tipton, Jr. (Battelle Memorial Inst., Columbus, Ohio). Feb. 1, 1961. Decl. Mar. 2, 1961. Contract W-7405-eng-92. 116p.

Work is reported on studies of: reactor materials and components; fuels; fuel element development; gas-pressure bonding of ceramic, cermet, and dispersion fuel elements; uranium carbide; growth of UO_2 crystals; radioisotope and radiation applications; void distribution and heat transfer; uranium mononitride; materials development and evaluation; coated-particle fuel materials; recovery of spent fuel elements; evaluation of fueled-graphite elements for pebble-bed reactors; fabrication processes for cold bonding Zircaloy-2 to type 410 stainless steel; radiation effects on fuel materials for MGCR; irradiation of SM-2 fuels; gas-cooled reactors; corrosion of thorium and uranium under storage conditions; and gas-pressure bonding of beryllium-clad fuel elements. (B.O.G.)

17877 (GEAP-3489) FREE-SURFACE SEPARATION OF STEAM AND WATER FOR APPLICATION IN A MARINE REACTOR AT 1000 PSIG. A. G. Steamer and H. D. Ongman (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). July 13, 1960. Contract AT(04-3)-189, PA No. 5. 87p.

A series of free-surface steam separation tests were carried out at 1000 psig to obtain data to aid in checking out analytical methods for the effect of ship's motion on steam separation. Data are presented on the shape and height of the steam-water interface with respect to the indicated water level for two vessel sizes. Further data are presented on the effects of water level and downcomer water velocity on steam carryunder. (auth)

17878 (K-1472) CRITICAL PATH SCHEDULING IN MAINTENANCE. C. L. Gritzner, J. P. Jones, and J. M. Ellis (Oak Ridge Gaseous Diffusion Plant, Tenn.). Apr. 10, 1961. Contract W-7405-eng-26. 23p.

Adaptation of the "Critical Path" Scheduling (CPS) technique and use of the Computer Facility have led to development of a more rapid and accurate method of evaluating and leveling ORGDP Maintenance man-power requirements. CPS is applied to multi-craft performance of short duration jobs after pre-selection of calendar time duration and specific limitations on the number of personnel and crafts involved. Developed schedules and supplementary data forms provide: 1) an efficient foreman's guide and check of work performance, 2) a versatile and rapid means of evaluating and improving present scheduling practices, and 3) a basis for job study, simplification, and subsequent

maintenance job cost reduction. Trial application of CPS for special maintenance work resulted in a 19.5% reduction of job labor costs. It is anticipated that further CPS application will reduce job labor costs as much as 30%. (auth)

17879 (MLM-1107) MOUND LABORATORY PROGRESS REPORT FOR NOVEMBER 1960. (Mound Lab., Miamisburg, Ohio). Nov. 30, 1960. Contract AT(33-1)-GEN-53. 14p.

Development studies were made of methods for producing adhesives and plastics having characteristics superior to those currently in use. Processes are being developed for separating and purifying radium-223, and potential thorium-230 sources of supply are being evaluated. Research was initiated to determine the density, viscosity, thermal capacity, thermal conductivity, and phase equilibria of plutonium and plutonium alloys proposed as fast breeder reactor fuels. Work is being conducted on the fabrication of plutonium-bearing glass fibers. (B.O.G.)

17880 (MLM-1112) MOUND LABORATORY MONTHLY PROGRESS REPORT FOR FEBRUARY 1961. J. F. Eichelberger (Mound Lab., Miamisburg, Ohio). Feb. 28, 1961. Contract AT-33-1-GEN-53. 17p.

A survey and re-evaluation of previous work on polyurethane and polyurethane-epoxy copolymer systems was initiated to determine which phases are more productive than others. The effects of varying excess polyol content were studied. Work was carried out to define the amounts of butamediol that the system Adiprene L-213-ferric acetyl acetate can tolerate and still be thoroughly cured. An experimental diallyl phthalate formulation was made and tested. A survey is being made of potential sources of kilogram quantities of Th^{230} in the United States. Analyses of various samples indicated concentrations almost three times as great as previously reported. The half-life of Ra^{223} was recalculated to include new data, and the results are reported as a function of the resolution time of the gas flow proportional counter. A method is being developed for determining the coincidence correction in proportional α counters by following the decay of a short-lived isotope. Additional determinations were made on the density of liquid cerium by the vacuum pycnometer method using tantalum pycnometers of about 0.5 cm^3 capacity. The viscosity of molten plutonium metal was investigated from 648 to 950°C with a cup viscometer. The construction of the high-temperature colorimeter was continued. Work was continued on the fabrication of plutonium-bearing glass fibers. (M.C.G.)

17881 (MLM-1113) MOUND LABORATORY MONTHLY PROGRESS REPORT FOR MARCH 1961. J. F. Eichel-

berger (Mound Lab., Miamisburg, Ohio). Mar. 30, 1961. Contract AT-33-1-GEN-53. 12p.

Adhesives. The effects obtained when diols and triols are used to cure Adiprene L-213 are discussed. Most of the formulations are very viscous and present difficulties in degassing operations. **Ionium Project.** Four plant samples having 1 ppm or more of Th^{230} were analyzed for Th^{230} in two different ways, one using HNO_3 digestion and the other using HClO_4 digestion. The difference between these two methods found for one sample is attributed to insolubility induced by calcining. **Half Life of Radium-223.** The decay of a purified Ra^{223} sample was followed by alpha counting for 109 days; the results indicate that a long-lived impurity may be the cause of the nonconvergence of the probable error in the resolution time range. Purification of a composite sample containing Ac^{227} to give a source of Ra^{223} is described. **Determination of Coincidence Correction.** The coincidence correction was determined for a proportional alpha counter with Pb^{211} , and the best resolution times and half lives are given. **Plutonium Alloy Research.** The density of liquid Ce was measured from 825 to 1000°C with the vacuum pycnometer method; the thermal coefficient of cubical expansion is found to be very small, $33 \times 10^{-6} \text{ cm}^3/\text{cm}^3/\text{C}$, and the volume change of fusion is also estimated to be small, less than 0.5%. The viscosities of molten La and Pr were determined from their melting points up to 996°C. Qualitative tests were made to study the wetting properties of Pu alloys on Ta. Pure liquid Pu did not wet Ta surfaces, but a Pu-43 at.% Co alloy had improved wetting properties. **Plutonium-bearing Glass Fibers.** Leaching tests were made at room temperature on glass fibers containing 10 wt.% Pu oxide. Leaching in water, 0.1 N HCl, and 0.5 N HNO_3 for 2206, 2183, and 1363 hr, respectively, resulted in respective losses of 0.15, 0.24, and 0.65% of the Pu oxide from the fibers. Additional leaching data for glass fibers containing 15 wt.% Pu oxide indicate that the rate of dissolution of Pu oxide is not related to the concentration of the Pu oxide but to that of the alkali metal oxides in the glass. Preliminary results are presented for the tensile strengths of glass fibers containing 20 wt.% Pu oxide. (D.L.C.)

17882 (NP-9675) EIGHTH ANNUAL REPORT, 1959-60. Being the Commission's Report for the Year Ended 30th June, 1960. (Australia. Atomic Energy Commission). 63p.

The activities of the Australian Atomic Energy Commission are reported for 1959 to 1960. These include surveys of uranium resources, uranium mining, raw materials, research, isotopes, nuclear power, and international agreements for co-operation. (W.L.H.)

17883 (NP-10113) THE FRENCH ATOMIC ENERGY COMMISSION, 1945-1960. (France. Commissariat à l'Energie Atomique, Paris). 73p.

The organization, objectives, and accomplishments of the French Atomic Energy Commission are reviewed. Topics discussed include the aims, resources and achievements, funds available, the results of prospecting and mining, the facilities available to scientists and research workers, activities in connection with scientific and technical training, the relationship between the A.E.C. and private industry, and the program of international cooperation. (C.H.)

17884 (TID-8531(Rev.)) COSTS OF NUCLEAR POWER. (Office of Operations Analysis and Forecasting, AEC). Jan. 1961. 46p.

A survey was made of the costs of nuclear power from stationary plants designed primarily for the generation of electricity. Plants in operation, being built, or being de-

signed for construction at an early date were considered. Research and development costs, construction costs, working capital, annual fixed charges, fuel-cycle costs, operation and maintenance costs, total generating cost, and objectives for competitive nuclear power in the United States are discussed. A list of names, owners and operators, and locations of nuclear power plants is included. (M.C.G.)

17885 (TID-11403) U.S.-EURATOM RESEARCH PROGRAM. (Division of International Affairs, AEC). [1960]. 34p.

Twenty-eight research projects sponsored by U.S.-Euratom are described. The projects include those begun in 1959 and 1960 and some that have not yet begun. (D.L.C.)

17886 (TID-12709) DRILLING AND GROUTING SUPPORT. FINAL REPORT, PROJECT COWBOY. James M. Polatty, Thomas B. Goode, Ralph A. Bendinelli, and Bill J. Houston (Waterways Experiment Station, Vicksburg, Miss.). Mar. 1961. 47p.

In Project COWBOY, conducted to develop information on ground motion caused by underground explosions, high explosive (HE) charges were fired in two large spherical cavities, 12 and 30 ft in diameter, excavated in a salt mine, and the resulting ground motion was compared with that obtained when similar yield tamped HE charges were fired in the same general vicinity. The ground motion was measured by instruments embedded in the immediate and general area. Drilling and grouting operations performed by the U. S. Army Engineer Waterways Experiment Station in connection with Project COWBOY are described. These operations included design of saltgrouts for grouting instrument and for stemming HE shot holes drilled in the salt; saltcrete for filling steel plugs used to seal the cavities; saltgrout for grouting in place steel liners and walkways in access tunnels to the cavities; and grouts for correcting for lost circulation of drilling mud in connection with the drilling of a 36-in.-diameter ventilation shaft into the mine. Salt cores from the mine were also tested to determine their physical properties. Crews and equipment were furnished for drilling and grouting 10,629 ft of vertical, horizontal, and sloping holes of various lengths and diameters, for which special tools and techniques were developed. In-place ultrasonic velocities of the salt near the cavities were determined. (auth)

17887 (UCRL-6251) RADIATION AND TEMPERATURE MEASUREMENTS OF THE NEPTUNE EVENT. J. Dal Peterson and Walter P. Bennett (California. Univ., Livermore. Lawrence Radiation Lab.). Jan. 1961. Contract W-7405-eng-48. 48p.

The radiation and temperature distributions and the definition of the zone of effect resulting from the Neptune event, a nuclear detonation fired on October 14, 1958 in a tunnel at the Nevada Test Site are given. The yield of the Neptune event was 115 ± 15 tons. The device was located at a point where the nearest approach to the surface was 98.5 ft and the scaled depth was 210 ft. On detonation, there was considerable venting and upheaval of material. Measurements of the temperature distribution ten months after the detonation revealed that temperatures up to $24 \pm 0.5^\circ\text{C}$, which is 10°C above the ambient temperature of $14 \pm 0.5^\circ\text{C}$, still existed in a region 13 ± 1 ft below ground zero and 5 ± 1 ft from ground zero directly opposite the portal. The methods and equipment used in obtaining data from the eleven holes drilled through the zone of effect are also presented. Integrations of the egg-shaped temperature distributions indicated that the total amount of energy added to the tuff in the form of thermal energy is

$(1.1 \pm 0.7) \times 10^{10}$ calories, or 9.6% of the total bomb energy of 11.5×10^{10} calories. The original cavity configuration, as determined from gamma and alpha activity, was defined as having radii of 60 ± 2 ft from ground zero toward the portal, 18 ± 2 ft below ground zero and 30 ± 2 ft from ground zero directly opposite the portal. (auth)

17888 (JPRS-4440) THE SIGNIFICANCE OF STABLE ISOTOPES. J. Muhlenpfordt. Translated from Kernenergie, 3: 816-21(1960). 13p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 15, abstract no. 1122.

17889 NUCLEAR ELECTRIC POWER FOR SPACE MISSIONS. Terry W. Koerner and John J. Paulson (California Inst. of Tech., Pasadena). Aero/Space Eng., 20: No. 5, 18-19; 44-6; 48-9(May 1961).

A comparison is made of the capabilities of chemical and nuclear power systems, in spacecraft propulsion and secondary power uses. Planetary fly-bys, orbits, and landings, and out-of-the-ecliptic missions are considered. Secondary power units include reactors, solar photovoltaic cells, and radioisotope thermoelectric generators. The uses of nuclear power systems in U. S. space missions planned for the 1960's are described. (T.F.H.)

17890 AEROSPACE NUCLEAR POWER SAFETY CONSIDERATIONS. Joseph A. Connor, Jr. (U.S.A.F. (MC)). Aero/Space Eng., 20: No. 5, 26-7; 58-61(May 1961).

Safety considerations in uses of nuclear power plants in space missions are detailed. The biological effects, probable amounts, dispersions, and locations of released radioactivity are considered. Engineering problems examined include personnel protection, site and range selections, and launching, pre-orbital, and random re-entry failures of vehicles. Aspects of manned nuclear aircraft, the Pluto nuclear ramjet, SNAP and Rover unit, and nuclear rocket safety are discussed. (T.F.H.)

17891 POWER SUPPLIES FOR SPACE VEHICLES. Nathan W. Snyder. Astronaut. Acta., 6: 271-310(1960). (In English)

Problems in the development of long-life electric power sources for space vehicles, for both propulsion and operation of the devices, are studied. Lifetimes and power requirements of power supplies for communications, navigation, and instrumentation of satellites; space, moon, and planetary stations; manned and maneuverable satellites are studied. Sources of solar, nuclear, and chemical energy; and energy conversion methods, including thermionic, thermoelectric, photovoltaic, photoemissive, and regenerative fuel cells, and turboelectric, reciprocating, and dynamic engine systems are studied. Environmental and stress problems encountered are described. (T.F.H.)

17892 ATOMIC ENERGY IN GERMAN FEDERAL REPUBLIC. Siegfried Balke. Nuclear Power, 6: No. 59, 57-90(Mar. 1961).

Atomic energy aspects in West Germany are reviewed. Topics covered include legal, economical, historical, and governmental positions. In addition, four new reactors are described, the high-temperature Brown Boveri-Krupp gas cooled pebble-bed power reactor, the boiling water Kahl power reactor, the Siemens pressurized heavy water power and research reactor, and the organic-cooled Interatom maritime reactor. Fuel element developments are examined; fabrication methods for fuel rods, tubes, plates, and pebble-bed elements are outlined. Research and power reactors, both planned and in use, are listed. Research facilities, including reactors, accelerators, and other installations are discussed. The work of the Deutsches Atom-Forum is reviewed. Organizations and companies participating in the German nuclear program are listed. (T.F.H.)

BIOLOGY AND MEDICINE

General and Miscellaneous

17893 (AERE-MED/M-19) A PUNCH-CARD SYSTEM APPLIED TO ROUTINE BIOLOGICAL SAMPLING. M. R. Trump (United Kingdom Atomic Energy Authority, Research Group, Atomic Energy Research Establishment, Harwell, Berks, England). July 1957. Decl. Aug. 18, 1960. 4p.

A punch card system is described which facilitates the regular selection of personnel for industrial hygiene sampling who are involved in handling toxic or active material. (J.R.D.)

17894 (AFOSR-TN-60-1406) RESEARCH ON "LOCALIZED RADIO-LESIONS." PART VI. RESTRICTED RADIO-LESIONS IN THE DEPTH OF THE BRAIN PRODUCED BY A BEAM OF HIGH ENERGY PROTONS. Technical Note No. 1. Lars Leksell, Borje Larsson, Bengt Andersson, Bror Rexed, Patrick Sourander, and William Mair (Uppsala Univ. Inst. of Anatomy and Uppsala Univ. Gustaf Werner Inst. for Nuclear Chemistry). June 1, 1960. Contract AF61(052)-183. 20p. (AD-247021)

Restricted lesions were produced in the depth of a goat's brain by means of cross-fire irradiation with a narrow beam of high energy protons. The radiosurgical technique and the histopathology of the lesions are described. It was possible to produce well circumscribed cerebral lesions of a type well suited for physiological experimentation without damaging surrounding nervous tissue. The method may also be applied to neurosurgery in man. (auth)

17895 (NAS-NRC-Pub-823) CONFERENCE ON MOLECULAR AND RADIATION BIOLOGY, GOULD HOUSE, DECEMBER 2, 3, AND 4, 1959, ARDSLEY-ON-HUDSON, NEW YORK. R. A. Deering, ed. (National Research Council. Committee on Nuclear Science). 1961. 146p.

Nuclear Science Series Report No. 31.

Separate abstracts were prepared for 11 of the 19 papers included. Abstracts were not prepared on the following: Duplication of DNA; Experiments on *E. coli* T⁺A⁻U⁻; Ultra-violet Effects on RNA and Enzymes; Nucleic Acid Synthesis in Regenerating Rat Liver; Bacterial Ribosomes; An Experimental Approach to Genetic Coding Problems; a discussion on the Possibility of Radiation Damage from Excitations; and introductory and summarizing remarks. (C.H.)

17896 A NEW METHOD FOR MASSIVE DUST EXPOSURES BY INHALATION. James D. Macewen, Edward C. J. Urban, Ralph G. Smith, and Arthur J. Vorwald (Wayne State Univ., Detroit). *Am. Ind. Hyg. Assoc. J.*, 22: 109-13 (Apr. 1961).

A chamber was designed which delivers a massive inhalation dose to anesthetized animals in a short period of time. The chamber consists of a vertically mounted cylinder with exposure ports arranged so that only the animals' heads are in the dust cloud. Studies were undertaken exposing Albino rats to strontium and rare earth oxides in the chamber. Data indicate that reproducible chamber concentrations are achieved, and that uniform pulmonary deposition of test material proportional to exposure time is accomplished. (auth)

17897 TRITIATED THYMIDINE AND THE STUDY OF TUMORS. W. E. Kisieleski, R. Baserga, and H. Lisco (Argonne National Lab., Ill. and Northwestern Univ., Medical School, Chicago). *Atompraxis*, 7: 81-5 (Mar. 1961). (In English)

Recent work on the proliferation of normal and tumor cells using tritiated thymidine is reviewed. It is shown how autography of labelled cells, in conjunction with radiochemical analysis of tritium in tissue slices, enables one to develop a quantitative treatment of the problem of cell proliferation, and how this contributes to an understanding of the kinetics of proliferation of normal and of tumor cells. (auth)

17898 EVALUATION OF PORTAL CIRCULATION BY PERCUTANEOUS SPLENIC ISOTOPE INJECTION. Robert H. Greenlaw and Seymour I. Schwartz (Univ. of Rochester, N. Y.). *J. Nuclear Med.*, 2: 85-93 (Apr. 1961).

A technique of splenic isotope injection for the evaluation of portal circulatory dynamics is presented. By tracing circulation to the liver and heart, considerable information can be gained concerning portal hypertension, speed of hepatic blood flow, and the presence of collateral venous return. (auth)

17899 A GENERAL METHOD FOR THE QUANTITATION OF IMMUNE CYTOLYSIS. Harold S. Goodman (Univ. of Chicago). *Nature*, 190: 269-70 (Apr. 15, 1961).

A test using Cr⁵¹-labeled cells was developed for quantitative measurements of immune lysis for cells derived from a variety of tissues. Procedures are described and data are tabulated from typical measurements of antibody cytolytic activity in tumor cells. (C.H.)

17900 RADIATION BIOPHYSICS. Howard L. Andrews. Englewood Cliffs, N. J., Prentice-Hall, Inc., 1961. 339p. \$11.35

Fundamentals of radiation biophysics are presented in a detailed and orderly manner. Emphasis is placed on those physical principles necessary to explain chemical and biological actions or to use available radiation sources safely. A logical sequence leads from a discussion of the primary process of radiation absorption through radiochemical reactions to observable injuries in a complex organism. The mathematical background is reviewed for the treatment of radiation mortality data, for analyzing experimental results for target size and shape, and for determining the hits needed for activation. The test is directed toward an elementary understanding of the subject at the undergraduate level. (C.H.)

Biochemistry, Nutrition, and Toxicology

17901 (AF-SAM-61-2) MECHANISM OF ACTION OF AET. THE RADIATION CHEMISTRY OF 2-MERCAPTOETHYLGUANIDINE AND BIS(2-GUANIDOETHYL) DISULFIDE IN AQUEOUS BUFFERED SOLUTIONS. Bernard Shapiro and E. Anne Dickens (Albert Einstein Medical Center, Philadelphia). July 6, 1960. 10p.

Issued by School of Aviation Medicine, Brooks AFB, Tex.

Aqueous buffered solutions of MEG and GED were irradiated with a 3-curie Co⁶⁰ gamma source. The radiation products were separated and identified by paper chromatography and electrophoresis. Irradiation of solutions of MEG produced GED. Irradiation of solutions of GED produced 2-guanidoethanesulfinic acid, taurocyamine, inorganic sulfate, and guanidine. G values were calculated for the oxidation of MEG at pH 6 (14.3 to 18.2), and for the oxidation of GED at pH 7.5 (0.29) and pH 8.5 (1.0). G values

were also calculated for the formation of 2-guanidoethane-sulfinic acid plus taurocyamine at pH 7.5 (0.42), and for the formation of inorganic sulfate and guanidine at pH 7.5 (0.17). The oxidation of MEG and GED by ionizing radiation indicated that these protective agents were capable of reacting with oxidizing free radicals formed in irradiated aqueous solutions. (auth)

17902 (AF-SAM-61-52) THE DISTRIBUTION AND METABOLISM OF 2-MERCAPTOETHYLGUANIDINE AND BIS(2-GUANIDOETHYL) DISULFIDE IN MICE. Bernard Shapiro and Emanuel E. Schwartz (Albert Einstein Medical Center. Radiology Dept., Philadelphia). Nov. 17, 1961. 8p.

Issued by School of Aviation Medicine, Brooks AFB, Tex. Various doses of MEG-S³⁵ and GED-S³⁵ were administered by oral and intraperitoneal routes to 8- to 10-week old C57BL/6J mice. The distribution of S³⁵ in the tissues of the animals was determined at various times. The metabolic forms of S³⁵ in the tissues of the animals were isolated and partially identified. It was found that S³⁵ concentrations were lowest in bone marrow and brain and highest in liver and kidney. Increasing doses of MEG-S³⁵ and GED-S³⁵ generally resulted in increasing tissue S³⁵ concentrations. After oral administration of the protective agent, as much as one-third of the administered dose was found in the gastrointestinal tract. This explained the need to use much larger doses for protection by oral administration of MEG or GED. More than half of the S³⁵ in the animal was in the protein-bound form. No other form was seen consistently in all tissues studied. It was suggested that the protein-bound form may be the protective form of MEG and GED. (auth)

17903 (BNL-5335) STABILITY OF RNA AND DNA IN BONE MARROW CELLS, STUDIED WITH TRITIATED CYTIDINE AND THYMIDINE. V. P. Bond, L. E. Feinendegen, and E. P. Cronkite (Brookhaven National Lab., Upton, N. Y.). [1961.] 21p.

Presented at the I.A.E.A. Conference on Tritium, Vienna, Austria, May 3-10, 1961.

DNA and RNA metabolism was studied in the bone marrow of the rat, using tritiated thymidine (H³Th), a specific precursor for DNA, and tritiated cytidine (H³C), a common precursor for both RNA and DNA. With H³C, differential incorporation into RNA, DNA, or the soluble pool at different times after administration of the precursor was determined autoradiographically in the single cell, and/or chemically for cell populations by means of differential extraction using appropriate treatment with perchloric acid. After the initial several hours, the curves for macromolecular RNA, DNA, and acid soluble RNA were found in general to be parallel in animals given H³C, and parallel to curves for tritium label in DNA following H³Th administration. The expected rate of falloff in label, from kinetics of the rat bone marrow cell populations studied separately by H³Th and autoradiography, assuming no turnover of RNA or DNA and loss of label only by loss of marrow cells by division and maturation, was in agreement with the slopes obtained. The results indicate that soluble and macromolecular RNA, once they are synthesized, are retained by the bone marrow cell in a manner indistinguishable from that for DNA. Data on RNA and DNA precursor relationships, and evidence for a late precursor for DNA following H³C administration are presented. (auth)

17904 (COO-223) RESEARCH IN RADIOBIOLOGY. Annual Progress Report on the Chronic Toxicity Program. Thomas F. Dougherty (Utah. Univ., Salt Lake City. Coll.

of Medicine). Mar. 31, 1961. Contract AT(11-1)-119. 31p.

Progress is reported in studies on the toxic effects of single injections of various doses of Ra²²⁶, Ra²²⁸, Pu²³⁹, Th²²⁸, and Sr⁹⁰ in dogs. Data are tabulated on injection dose levels and pathological effects. (C.H.)

17905 (IEA-26) ABSORCAO DA VITAMINA B-12 (CO-60) EM PACIENTES GASTRECTOMIZADOS. (Absorption of Vitamin B-12 (Co-60) in Gastrectomized Patients). J. Rozenbojm, R. R. Pieroni, S. Kurban, J. Schnaider, N. Kusminski, A. B. de Ulhoa Cintra, C. de Moura Campos, and S. Honda (Sao Paulo, Brazil. Universidade. Instituto de Energia Atomica). 1960. 7p.

The absorption of radioactive vitamin B₁₂ was studied in subtotal gastrectomized patients with either Billroth I or Billroth II anastomosis and in total gastrectomized patients. The results were compared with absorption in a control group of non-gastrectomized patients. Absorption was evaluated through fecal excretion using the Halsted technique and through urinary excretion using the Schilling procedure. It was concluded that all the subtotal gastrectomized patients have a normal absorption of vitamin B₁₂, but the total gastrectomized patients have a deficient absorption. The presence or absence of free gastric acid does not appear to have any value in the absorption of vitamin B₁₂. (auth)

17906 A POSSIBLE EXPLANATION OF THE ANOMALOUS BIOLOGICAL ISOTOPIC EFFECTS OBSERVED IN D₂O¹⁸ AND H₂O¹⁸. S. Z. Roginskii and S. E. Shnol'. Doklady Akad. Nauk S.S.S.R., 137: 706-9 (Mar. 21, 1961). (In Russian)

It has been observed that certain single-cell microorganisms such as algae or E. coli, when grown in 70 to 100% D₂O, first pass into an anabiotic state in which cell growth and division are inhibited. Part of the cells may continue to grow without division to enormous dimensions. However, after a certain period of time, adaptation occurs with normal growth and division. The same behavior is observed when the medium is changed from D₂O to ordinary water. Since this adaptive behavior has been observed for E. coli in going from H₂O¹⁶ to 92% H₂O¹⁸, and from 92% H₂O¹⁸ back to H₂O¹⁶, and since no perceptible isotopic effect is observed on replacing all the light nitrogen in the cell by N¹⁵, it is felt that the theory of hydrogen bonding does not explain the facts adequately. It is argued that the adaptive changes observed can be more logically explained by changes in the molecular weight of the hydration shell around various micromolecules in the cell. It is predicted that if the molecular weight of the water and not the isotopic composition is controlling the process, then microorganisms adapted to D₂O should multiply readily in H₂O¹⁸ after being dried out to the point where almost all the structural water has been removed. (TTT)

17907 THE PANCREAS SPECIFICITY OF Se⁷⁵-SELENOMETHIONINE. Monte Blau and Robert F. Manske (Roswell Park Memorial Inst., Buffalo). J. Nuclear Med., 2: 102-5 (Apr. 1961).

Se⁷⁵-selenomethionine was prepared. This compound shows the pancreas specificity characteristic of amino acids. About 6% of the dose can be found in the pancreas 2 hr after administration and the concentration in the pancreas is as high as 8 or 9 times that found in the liver. This distribution data and the radiation characteristics of Se⁷⁵ suggest that Se⁷⁵-selenomethionine might be useful for visualization of the pancreas by isotope scanning techniques. (auth)

17908 THE SENSITIVITY OF THE LIVER TO CERTAIN BILE-STIMULATING SUBSTANCES ON INJECTING POLO-

NIUM INTO AN ORGANISM. L. L. Fedorovskii. Med. Radiol., 6: No. 1, 83-4 (Jan. 1961). (In Russian)

Four dogs were subcutaneously injected with 0.04 mc/kg of Po, and with 0.4 ml/kg of a 5% solution of decholin or with 0.3 units/kg of insulin. The stimulation in flow of bile and the concentration of bile acids were followed during various stages of the radiation sickness. In the first few days of the radiation sickness the reaction of the liver to these reagents is normal. The flow of bile and of bile acids is stimulated. On the 6th day the reaction is normal (the same as was obtained before the injection of Po). The flow of bile and bile acids is below normal on the 15th day of the radiation sickness (the climax) and later. (TTT)

17909 LEAD-210 IN SOME HUMAN AND ANIMAL TISSUES. C. R. Hill and Z. S. Jaworowski (Royal Cancer Hospital, London). Nature, 190: 353-4 (Apr. 22, 1961).

Measurements were made of the levels of stable Pb and Pb^{210} in samples of human and animal bone and liver. Results are tabulated and compared with results of similar measurements. (C.H.)

17910 DECORPORATION OF RADIONUCLIDES (STUDIES WITH RADIOCERIUM AND DIETHYLENETRIAMINEPENTAACETIC ACID). Alexander Catsch (Kernforschungszentrum Karlsruhe, Ger.). Strahlentherapie, 114: 565-76 (Apr. 1961). (In German)

The influence of diethylenetriaminepentaacetic acid (DTPA) on the excretion of carrier free radiocerium from the organs of the rat was studied. The effectiveness of a single DTPA dose extends over several days, and depends on the biological half-time of radiocerium in the different organs. The dependence of the skeletal effectiveness of DTPA on the time of its administration is less pronounced in mature animals than in young rats. Repeated DTPA doses fail to give an additivity of effectiveness. The effectiveness of DTPA does not depend on the duration of administration. Na_3 -DTPA is more effective in mobilizing radiocerium from the skeleton than $CaNa_3$ -DTPA. (auth)

Fallout and Ecology

17911 (TID-12309) A THIRD REPORT ON TRANSLOCATION OF RADIOACTIVE PHOSPHORUS (P^{32}) IN A MICHIGAN TROUT STREAM. Progress Report. R. C. Ball (Michigan State Univ., East Lansing) and F. F. Hooper (Michigan. Inst. for Fisheries Research, Ann Arbor). 1960. Contract AT(11-1)-655. 20p.

Results are reported from a study on the incorporation of P^{32} into the food chain in a fresh water stream. Radioactivity in water, plants, insects, invertebrate animals, and fish was measured following the introduction of a concentration of 1.22×10^{-5} mc/ml of P^{32} into waters of the West Branch of the Sturgeon River, Mich. Results are compared with results from similar studies during 1958 and 1959. An attempt was made to relate uptake to the amount of P present. The influence of chelating agents on the distribution of activity was also studied. (C.H.)

17912 (TID-12432) PRELIMINARY REPORT ON TRANSLOCATION OF RADIOACTIVE PHOSPHORUS (P^{32}) IN A MICHIGAN TROUT STREAM. Progress Report, June 14, 1958-March 11, 1959 on A STUDY OF PRODUCTIVITY IN A STREAM ECOSYSTEM. R. C. Ball (Michigan State Univ., East Lansing) and F. F. Hooper (Michigan. Inst. for Fisheries Research, Ann Arbor). Contract AT(11-1)-655. 28p.

On Aug. 5, 1958, an addition of P^{32} was made to the West Branch of the Sturgeon River in the vicinity of Wolverine, Mich. The objectives of the experiment were to determine

how the naturally occurring P of a trout stream is used by plants and animals and to determine by what mechanisms P is transported in a trout stream. The information will be used to understand how P in the form of fertilizers can be used in streams to increase the production of trout. Data are presented on the activity of stream water during passage of the isotope, and the activity of plants, invertebrate animals, and fish collected at various times. Results indicate that the natural P of the stream water is continuously being exchanged with the P in living plants and animals. (C.H.)

17913 (TID-12433) A SECOND REPORT ON TRANSLOCATION OF RADIOACTIVE PHOSPHORUS (P^{32}) IN A MICHIGAN TROUT STREAM. R. C. Ball (Michigan State Univ., East Lansing) and F. F. Hooper (Michigan. Inst. for Fisheries Research, Ann Arbor). 1959. Contract AT(11-1)-655. 33p.

Phosphorus-32 was released in the West Branch of the Sturgeon River, Michigan, on July 8, 1959, at a theoretical maximum concentration of 1.22×10^{-5} mc/ml. Studies were made on the movement of radiophosphorus through the food chain during a two-month period. Data are presented on total water activity at various collecting stations during passage of the isotope, the activity of solids filtered from the water, the activity of plants collected at various stations throughout the experimental period, the activity of bottom-dwelling invertebrates, the activity of insects, and the activity of fish collected at various locations. Results are compared with results from a similar study done in 1958. (C.H.)

17914 MEASUREMENT OF THE RADIOACTIVE CONTAMINATION OF THE FOOD CHAIN. A. Chevallier and R. Schneider (Faculte de Medecine, Strasbourg). Bull. inst. natl. hyg., 16: 207-18 (Jan.-Feb. 1961). (In French)

The results obtained at the Laboratoire de Protection of l'Institut de Physique Biologique, Strasbourg, from 1958 to 1960 on the contamination of food are tabulated. The methods used for the measurement of the total β activity and for the radiochemical separations and determination of the elements isolated are described for milk and vegetables. The activities found in milk, vegetables, and animal skeletons are given in tabular form. (J.S.R.)

17915 THE INCREASE IN CONTENT OF RADIOACTIVE CARBON AS A RESULT OF NUCLEAR EXPLOSIONS. A. P. Vinogradov, A. L. Devirts, and E. I. Dobkina. Doklady Akad. Nauk S.S.S.R., 137: 688-91 (Mar. 21, 1961). (In Russian)

The distribution of the C^{14} content in the annual tree rings of an ash tree (*Fraxinus excelsior*) was determined by beta counting 2.0 g of carbon in the form of ethane gas on a proportional counter. It was found that the increase in C^{14} content averaged 5.5% for the last 4 years (from 1956 to 1959-1960). The total increase in C^{14} content was 30% as compared to the 1953 level of C^{14} . It is recommended that the C^{14} content in annual tree rings of forest trees be accepted as a standard for the determination of C^{14} in the atmosphere at various periods of time. (TTT)

Radiation Effects on Living Tissues

17916 (AF-SAM-61-50) EFFECTS OF POSTIRRADIATION CHRONIC COLD STRESS ON IRRADIATED RATS. J. J. Gambino, M. S. Billings, B. G. Lamson, and L. R. Bennett (California. Univ., Los Angeles. School of Medicine). Nov. 10, 1960. 6p.

Issued by School of Aviation Medicine, Brooks AFB, Tex.

A comparison was made of the long-term response of

rats to chronic, intermittent cold stress administered following whole-body irradiation, adrenal irradiation, and no irradiation. There was no significant difference in longevity or time of appearance of external neoplasms when any of the cold stressed groups were compared with their noncold stressed controls. (auth)

17917 (K-1470) IS ALL NUCLEAR RADIATION HARMFUL? Hugh F. Henry (Oak Ridge Gaseous Diffusion Plant, Tenn.). May 2, 1961. Contract W-7405-eng-26. 25p.

An analysis is made of available experimental results on the longevity effects of chronic low-level radiation upon animals. It is shown that a statistical average life-lengthening effect occurs at chronic life-time radiation exposure levels below about 2 to 5 rad/week; for higher exposures, a life-shortening effect is observed although the data do show variations among animals. Similarly, available data on chronic internal exposures resulting from injection of radioisotopes show that for such materials of interest as plutonium and uranium statistical life-lengthening effects also occur for comparatively low injections where higher injections produce life shortening. The principal sources of human data are statistical studies on the longevity of radiologists, and these also indicate an apparent greater life expectancy for this group as compared to physicians in general. It is noted that available data do not permit unequivocal determination of the overall genetic effects of low levels of radiation, primarily because the data do not clearly indicate environmental selection principles. Some of the philosophical bases involved in evaluating the over-all somatic and genetic effects of low levels of radiation are briefly discussed. 53 references. (auth)

17918 (NAS-NRC-Pub-823(p.21-6)) RADIATION EFFECTS ON MACROMOLECULES. Franklin Hutchinson (Yale Univ., New Haven).

Two mechanisms of radiation action on molecules in cells are discussed. In direct action the radiation energy is released directly in a molecule to inactivate it, and in indirect action the radiation produces radicals in the surrounding solution, and these radicals diffuse to the biological molecule and inactivate it. Differences in radiosensitivity of wet and dry states and correlation between sensitive volume and actual molecular size are discussed. Applications of radiation response in estimates of molecular sizes are discussed. Data are tabulated on the sensitivity of trypsin to different radiation doses from several sources, the radiation inactivation of enzymes in cells irradiated in both the wet and the dry state, and the effects of irradiation of pneumococcus cells on the transforming principle in desoxyribonucleic acid. (C.H.)

17919 (NAS-NRC-Pub-823(p.27-30)) RADICAL YIELD FROM IRRADIATION OF DRY MATERIAL. John Kirby-Smith (Oak Ridge National Lab., Tenn.).

Electron spin resonance measurements were used to study the number of free radicals produced in certain dried biological materials as a function of radiation energy absorbed. Data are tabulated for amino acids, various proteins, and pure desoxyribonucleic acid. (C.H.)

17920 (NAS-NRC-Pub-823(p.31-4)) RADIATION EFFECTS ON RNA FROM TOBACCO MOSAIC VIRUS. Amos Norman (California. Univ., Los Angeles. Medical Center).

Data are presented on the effects of ultraviolet light on the chemical structure of ribonucleic acid and desoxyribonucleic acid. The effects of temperature and pH on reversibility of radiation effects in tobacco mosaic virus and the effects of water on radiosensitivity of DNA and RNA are

discussed. Data are compared with that from studies on the biological effects of x radiation and incorporated P³² in bacteriophage. The photoreactivation of ultraviolet radiation damage and heat inactivation of polio virus are discussed. (C.H.)

17921 (NAS-NRC-Pub-823(p.42-6)) THERMOLUMINESCENCE STUDIES FOLLOWING IRRADIATION. Leroy G. Augenstine (Atomic Energy Commission, Washington, D. C.).

Results are reported from studies on thermoluminescence in NaCl crystals, amino acids, and proteins irradiated at low temperatures. Electronic rearrangements occurring after initial radiation reaction are discussed. (C.H.)

17922 (NAS-NRC-Pub-823(p.53-5)) RADIATION EFFECTS IN DRY SEEDS. Howard Curtis (Brookhaven National Lab., Upton, N. Y.).

Data are presented on the effects of radiation on dry seeds. Radiation damage appeared to increase with holding time. It is suggested that radicals are produced which can remain and move around in the dry state to reach a sensitive region, but when water is added the radicals are dissipated. An alternate hypothesis is that the nucleus is a complex structure and that damaged centers are formed in the DNA. It is suggested these could remain in the dry state and pull apart with time, while if H₂O is added, these could heal themselves. Results are included from electron spin resonance measurements on the embryos of γ -irradiated seeds. (C.H.)

17923 (NAS-NRC-Pub-823(p.58-71)) POST-IRRADIATION METABOLIC EFFECTS ON ULTRAVIOLET-INDUCED MUTATION. Charles O. Doudney (Texas. Univ., Houston. M. D. Anderson Hospital and Tumor Inst.).

Results are reported from studies on the influence of metabolic factors on the induction of mutations by ultraviolet radiation. Data are tabulated on the effect of post-irradiation incubation on reversion in *E. coli*. It is concluded that amino acids are essential in the metabolism leading to mutation. Reaction mechanisms involved are summarized. (C.H.)

17924 (NAS-NRC-Pub-823(p.72-90)) RADIATION EFFECTS ON MAMMALIAN CELLS GROWN IN CULTURE. Mortimer M. Elkind (National Cancer Inst., Bethesda, Md.).

Results are reported from studies on the effects of radiation on mammalian cells grown in tissue culture. Reaction mechanisms involved in the biological effects of radiation at the cellular level are discussed. (C.H.)

17925 (NAS-NRC-Pub-823(p.91-4)) RECENT WORK IN YEAST RADIOBIOLOGY. Robert Mortimer (California. Univ., Berkeley).

Results are reported from studies of survival and allelic recombination in yeast cells exposed to x radiation. Data are compared with results of studies using ultraviolet radiation. The reversion of radiation injuries is discussed. Data are tabulated on reversion to arginine independence of heteroallelic zygotes formed by one irradiated and one unirradiated parent. (C.H.)

17926 (NAS-NRC-Pub-823(p.103-6)) RADIATION SENSITIVE COMPONENTS OF A BACTERIAL DNA SYNTHESIZING SYSTEM. Daniel Billen (Texas. Univ., Houston. M. D. Anderson Hospital and Tumor Inst.).

Results are reported from studies on the nature of x-ray induced damages in the desoxyribonucleic acid synthesizing system of *Escherichia coli*. Data are tabulated on synthesis before and after irradiation. It is concluded that interference with protein synthesis prior to x-ray exposure can

greatly increase the radiation sensitivity of the DNA synthetic mechanism. Possible mechanisms involved are discussed. (C.H.)

17927 (NAS-NRC-Pub-823(p.107-13)) RADIATION EFFECTS ON DNA AND RNA SYNTHESIS IN L-STRAIN CELLS. Gordon Whitmore (Toronto. Univ.).

Results are reported from studies on the effects of massive doses of radiation on the synthesis of DNA and RNA and on mitosis in mouse cells grown in tissue culture. Data indicate that the principal effect of radiation is to induce a single block in the cell division and that observed effects on DNA and RNA synthesis are the result of this block rather than the result of direct radiation action on DNA synthesis itself. (C.H.)

17928 (NAS-NRC-Pub-823(p.138-43)) EFFECT OF IONIZING RADIATION ON AMINO ACID UPTAKE BY *E. COLI*. Ernest C. Pollard (Yale Univ., New Haven).

Results are reported from studies on the effect of ionizing radiation on the ability of *E. coli* to metabolize amino acids. Data are presented graphically. Results on sensitive volume and sensitive area are analyzed to give an estimate of the size and shape of the sensitive region. (C.H.)

17929 (NP-9529) RECOMMENDED EXPERIMENT TO DETERMINE THE RELATIONSHIP OF ACUTE AND DELAYED EFFECTS OF EXTERNAL RADIATION, AND THE SUGGESTED METHOD OF TREATMENT. PART I. Crawford F. Sams. PART II. Jean Pierre Imhof (California. Univ., Richmond. Inst. of Engineering Research). Aug. 30, 1957. 35p.

Results are summarized from a study of the effects of radiation and natural aging on certain measurable phenomena in the fields of endocrinology, metabolism, nutrition, and pathology in rats. A series of experiments is outlined which was devised to determine whether the postulated cause and effect relationships do exist. The effectiveness of several therapeutic treatments in attenuating the stress reaction and early aging resulting from irradiation will also be investigated. (C.H.)

17930 (NYO-9634) THE EFFECT OF WHOLE-BODY X-IRRADIATION ON THE PHYSICAL, CHEMICAL AND BIOCHEMICAL PROPERTIES OF NUCLEOPROTEIN. Final Progress Report, November 1, 1959-January 15, 1961. Herbert J. Eichel and Jay S. Roth (Hahnemann Medical Coll. and Hospital, Philadelphia). Contract AT(30-1)-2118. 35p.

Results are reported from studies on the biochemical effects of x radiation on suspensions of *Tetrahymena pyriformis* in water. The effects of the addition of lactate or thioctic acid and the effect of increasing the radiation dose level on oxygen consumption were studied. The results are discussed and explained on the basis of changes in permeability of the cell membranes induced by the radiation exposure. Results are also included from studies on the effects of x irradiation on the properties of ribonuclease in rat spleen and the effects of x irradiation on a demethylating system in rat liver. Data are included from a series of studies on the intracellular distribution pattern of rat liver glutamic-oxalacetic transaminase. (C.H.)

17931 (UCLA-474) INABILITY OF WHOLE BODY X-IRRADIATION TO PRODUCE EXTINCTION OF CONDITIONAL AVOIDANCE IN RATS. Thomas J. Haley, J. Fonseca, N. Komesu, and P. Williams (California. Univ., Los Angeles. School of Medicine). May 5, 1961. Contract AT(04-1)-GEN-12. 10p.

When rats had been conditioned to either sound or light and subsequently were subjected to acute whole-body x irradiation in doses of 300 to 900 r, there was no ex-

tingtion of the response to the conditional stimulus. No statistically significant difference was observed between the pre- and post-irradiation responses of the conditioned animals. More trials were required to condition the animals to light than to sound. The neurophysiological basis for the failure of x irradiation to produce extinction of the conditioned response is discussed. (auth)

17932 (UCRL-9592) THE LIPID SYNDROME IN MAMMALIAN RADIOBIOLOGY WITH EMPHASIS ON POSTIRRADIATION PROTECTION OF ANIMALS WITH LIPIDS (thesis). James K. Ashikawa (California. Univ., Berkeley. Lawrence Radiation Lab.). Mar. 1, 1961. Contract W-7405-eng-48. 127p.

Results are reviewed from studies which showed conclusively that post-irradiation olive-oil treatment approximately doubles the survival of mid-lethally irradiated male mice. Olive oil is still beneficial when administered to animals 24 hr after whole-body irradiation. The efficacy of a number of other fatty materials against x radiation was tested to determine whether this protective effect was peculiar to olive oil. Among these, methyl oleate, triolein, and peanut oil were equally effective as olive oil. Safflower oil fortified with antioxidant was also beneficial. Methyl stearate is considered dietarily unessential, but it too was helpful. On the other hand, methyl palmitate was ineffective. Data are tabulated. 428 references. (auth)

17933 (USNRDL-TR-504) LIPIDS OF THE RAT LIVER MITOCHONDRIAL MEMBRANE: EFFECT OF X-IRRADIATION. K. L. Jackson and C. Entenman (Naval Radiological Defense Lab., San Francisco). Apr. 11, 1961. 31p.

An investigation of the lipids of the mitochondrial membrane from rat liver indicates that the mole % lipid composition of the membrane is cephalin 55%, lecithin 34%, cholesterol 3%, and glycerides 8%. The phosphatides are phosphatidyl choline, phosphatidyl ethanolamine, and a small amount of phosphatidyl serine. The fatty acid composition of the membrane phospholipids were determined by gas chromatography. Evidence in the literature indicates that liver mitochondria are damaged as a result of whole-body irradiation. Data obtained in the present study show that irradiation does not cause a loss of any of the major classes of lipids from the mitochondrial membrane during the first 40 minutes following 1000 r whole-body x irradiation. Because x irradiation is known to destroy unsaturated fatty acids, it is of interest that there was no loss of unsaturated fatty acids from the membrane phospholipids. Rather, irradiation caused an increase in the amounts of the unsaturated fatty acids, linoleic and arachidonic acid, in the phosphatidyl choline fraction of the membrane. It is clear that whatever the mechanism is, whereby liver mitochondria are altered during an early period following irradiation, it does not involve major destruction of lipids in the mitochondrial membrane. (auth)

17934 EFFECTS OF IONIZING RADIATION ON ARYLESTERASE AND CHOLINESTERASE. Klas-Bertil Augustinsson, Gunnel Jonsson, and Berndt Sparrman (Univ. of Stockholm). Acta. Chem. Scand. 15: 11-15(1961). (In English).

The effects of Co^{60} γ radiation on arylesterase and cholinesterase of human blood plasma were compared using solid preparations of purified enzymes containing various amounts of water. In the case of cholinesterase a water content of 12% exerted maximum protection against irradiation. Such a protection by water was not observed with arylesterase. In aqueous solutions cholinesterase was

more resistant to irradiation by γ rays than was arylesterase when irradiation was performed in an atmosphere of nitrogen. (auth)

17935 THE RELATIVE BIOLOGICAL EFFECT OF P^{32} β RADIATION. I. COMPARISON OF P^{32} β RADIATION AND X-RAYS AS TO THEIR BIOLOGICAL EFFECTS ON DROSOPHILA MELANOGASTER EGGS. Tadeusz Rudnicki. Acta Physiol. Polon., 12: No. 1, 145-57 (Jan.-Feb. 1961). (In Polish)

No differences were found between the biological effects of 70 kv x rays and β particles from P^{32} on eggs of *Drosophila melanogaster*. (C.H.)

17936 THE RELATIVE BIOLOGICAL EFFECT OF P^{32} β RADIATION. II. COMPARISON OF P^{32} RADIATION AND X-RAYS AS TO THEIR BIOLOGICAL EFFECTS ON THE GROWTH OF PEA RADICLES AND MITOTIC FUNCTIONS IN VICIA FABA RADICLES. Tadeusz Rudnicki. Acta Physiol. Polon., 12: No. 1, 159-71 (Jan.-Feb. 1961). (In Polish)

Results are reported from a study on the comparative biological effects of β particles from P^{32} and 70 kv x rays on the growth of pea radicles and mitotic function in *Vicia faba*. Beta particles were less effective than x radiation in producing biological effects. (C.H.)

17937 A COMPARISON OF THE INFLUENCES OF LOW AND MEDIUM ENERGY X-RAYS ON THE ROOT TIP CHROMOSOMES OF VICIA FABA. I. Müller and E. A. Lobbecke (Universität, Cologne). Atompraxis, 7: 103-9 (Mar. 1961). (In German)

The effects of 10 and 100 kv x radiation on the root tip chromosomes of *Vicia faba* were compared. The number of chromosomal aberrations detectable at anaphase was higher for the 100 kv radiation for both the primary and secondary effects. This difference can be explained through the greater absorption of the 10 kv radiation by the root tips. The number of chromosomal fragments, but not the number of bridges, was higher in the 100 kv series. The number of bridges relative to the number of fragments was greater in the 10 kv treatments. Possible explanations of this difference are discussed. The different experiments showed a high variability in the effects of the radiation; this may be the result of uncontrolled environmental factors which affect the sensitivity of the chromosomes to x radiation. (auth)

17938 MODIFICATION OF MYOSINE B BY THE GAMMA RAYS OF Co^{60} . Ingrid Pinset-Harstrom. Bull. inform. sci. et tech. (Paris), No. 46, 81-6 (Dec. 1960). (In French)

The isotopic substitution of D for the ordinary H in the water of dissolution to modify the stability of the H bonding was studied. The presence of 75% D_2O in the aqueous solvent does not appear to modify the ultracentrifugation of myosine B. Gamma irradiation causes the appearance of heavy polymers. These polymers appear at a lower dose with D_2O in the solvent. The heat-induced polymerization is produced at a lower temperature for D_2O solvent than for H_2O . The theoretical significance of these results is discussed. (J.S.R.)

17939 PROCAINE AND DERIVATIVES IN CHEMICAL PROTECTION AGAINST THE γ RADIATION OF Co^{60} . J. Cheymol, P. Chabrier, M. Adolphe, and M. Selim (Faculté de Médecine, Paris). Compt. rend. soc. biol., 154: 1761-2 (Oct. 1960). (In French)

The radioprotective action of complexone III-procaine, p-aminobenzoic acid, and the ortho and meta isomers of this acid against Co^{60} γ rays was studied and compared to

the radioprotective effects of procaine, cysteamine, and aminoethyl isothiurea. The results showed that these compounds have a protective action inferior to that of procaine. In the three aminobenzoic acids the decreasing order of activity is ortho-para-meta. Procaine has a protective action at least equal to cysteamine and aminoethyl isothiurea. (J.S.R.)

17940 EFFECT OF X RAYS ON THE MIDDLE INTESTINE OF BLABERA FUSCA BR. Micheline Mortreuil-Langlois (Faculté des Sciences, Paris). Compt. rend. soc. biol., 154: 1769-70 (Oct. 1960). (In French)

The appearance of radiolesions of the mucous membrane of the middle intestine was studied in *Blabera fusca* (Orthoptera) irradiated with a dose of 25,000 r. The most radiosensitive cells are the regeneration cells at the moment of their differentiation in secretor elements. The irradiation does not suppress the secretion of epithelial cells. (tr-auth)

17941 CHROMATOGRAPHIC STUDY OF HUMAN PLASMA AFTER HIGH DOSES OF RADIOACTIVE IODINE. Nicole Etling (Groupe Hospitalier Necker Enfants malades, Paris). Compt. rend. soc. biol., 154: 1779-82 (1960). (In French)

A detailed chromatographic study was made of the transformation of iodoamino acids of plasma following therapeutic administration of I^{131} in patients having vesicular cancer of the thyroid. An n-butanol acid extraction is made, and the insoluble fraction is treated with a solution of NaCl. The extractable fraction contains, principally in the first hours, triiodothyrosine, but in some cases the "F body," whose nature is still unknown, is found. The fraction insoluble in butanol contains iodothyrosines. The moniodothyrosine always predominates, if it is not alone. It is not exceptional, however, to find diiodothyrosine. (J.S.R.)

17942 DEOXYRIBONUCLEIC ACID SYNTHESIZING CELLS IN THE BLOOD OF MAN AND DOG EXPOSED TO TOTAL BODY RADIATION. V. P. Bond, T. M. Flidner, E. P. Cronkite, and G. Andrews (Brookhaven National Lab., Upton, N. Y. and Oak Ridge Inst. of Nuclear Studies, Tenn.). J. Lab. Clin. Med., 57: 711-17 (May 1961).

With the use of tritiated thymidine, which is incorporated only into new desoxyribonucleic acid, and the autoradiographic technique, it was possible to show that cells capable of desoxyribonucleic acid synthesis and thus, presumably, of division are present normally in the blood. In the present investigations the number of these cells was followed serially in five men exposed to large doses of whole-body radiation in an accident involving fissionable material. Similar studies were performed on irradiated dogs to confirm and extend these observations. Following exposure the number of cells falls drastically within hours (normal values approximately 6 per cubic millimeter for human being; 60 per cubic millimeter for dog). The values then rise gradually, to attain levels exceeding normal approximately ten days after exposure of the human being. A second peak exceeding normal levels is noted at approximately forty days. The cells are all of the large mononuclear type. The possible fate and function of these cells are discussed. (auth)

17943 TUMORIGENESIS IN TRANSPLANTED IRRADIATED AND NONIRRADIATED OVARIES. W. U. Gardner (Yale Univ. School of Medicine, New Haven). J. Natl. Cancer Inst., 26: 829-47 (Apr. 1961).

Over 300 hybrid mice were used to determine the incidences of ovarian tumors after irradiation and transplantation of ovaries. Female mice were given 87 or 175 r total-body radiation. Ovaries of these and non-irradiated

donors were permitted to remain in place or transplanted subcutaneously or intratesticularly in male hosts. Some irradiated female mice received subcutaneous transplants of nonirradiated ovaries or of testes. Most of the intact and unilaterally castrated males had ovarian granulosa-cell tumors 600 to 700 days after a non-irradiated ovary was placed in the testis. Only about a third of the irradiated ovaries similarly grafted became tumorous. Nonirradiated ovaries grafted subcutaneously became tumorous in all the castrated male hosts, and two thirds of the irradiated ovaries became tumorous when transplanted in castrated male hosts. Approximately two thirds of the intact irradiated females and one third of the unilaterally ovariectomized, irradiated mice had ovarian tumors at death. Only 8 percent of the irradiated females that had an ovary transplanted subcutaneously from a young donor had ovarian tumors at death. Grafts of testis did not inhibit ovarian tumorigenesis. The environment provided by the male favored either ovarian tumorigenesis in grafted ovaries from both nonirradiated and irradiated donors or the growth of cells that had become tumorous. The incidence of lymphomas was higher in the male mice bearing grafts of irradiated ovaries. Two male mice bearing granulosa-cell tumors of the follicular type had mammary adenocarcinomas at death. (auth)

17944 THE INFLUENCE OF IONIZING RADIATION ON THE NERVOUS SYSTEM IN DELETERIOUS OCCUPATIONAL CONDITIONS. K. B. Skvirskaya (Scientific Research Center, Inst. of Medical Radiology, Ministry of Public Health, USSR). *Med. Radiol.*, 6: No. 1, 5-9 (Jan. 1961). (In Russian)

Data concerning the examination of 92 roentgenologists and roentgen technicians with a long service record are given. An inference is drawn to the effect that in roentgenologists and roentgen technicians working under deleterious conditions the neurological symptoms are not a prominent feature. In connection with this there arises a necessity to reconsider the problem pertinent to the importance of the astheno-vegetative syndrome in the complex of chronic radiation sickness. (auth)

17945 EFFECTS OF IONIZING RADIATIONS ON RICE PLANTS. Maung Mya Thauang (Union of Burma Atomic Energy Centre, Yankin P.O., Rangoon). *Nature*, 190: 242-3 (Apr. 15, 1961).

Seeds of five varieties of Burmese rice were exposed to doses of 25 or 35 kr of x radiation. The seeds were sprouted after 3 to 7 weeks. Data are tabulated on seed germination, seedling fatality, seedling height, number of panicles and grains, percentage of grain fertility, susceptibility to false smut, and date of heading. Applications of radiation in the production of useful mutations are discussed. (C.H.)

17946 THE EFFECTS OF X-IRRADIATION IN I^{131} -LABELED IODOTYROSINES IN SOLUTION: THE SIGNIFICANCE OF REDUCING AND OXIDIZING RADICALS. Rosalyn S. Yalow and Solomon A. Berson (Veterans Administration Hospital, New York). *Radiation Research*, 14: 590-604 (May 1961).

Effects of x irradiation on I^{131} -labeled L-3-monoiodotyrosine (MIT) and L-3,5 diiodotyrosine (DIT) were studied by using paper chromatography and electrophoresis for identification of the irradiation products. Irradiation of MIT in nitrogen results in tyrosine and iodide as the principal products; irradiation in air results in tyrosine, dihydroxyphenylalanine, and iodide. Irradiation of DIT in nitrogen results in MIT, hydroxymonoiodotyrosine (presumptive), and iodide. In all cases the yield is increased in

the absence of oxygen. Fenton's reagent does not produce the chemical changes observed after x-irradiation. The results suggest that in a nitrogen atmosphere H \cdot radicals are primarily responsible for the alterations, in air both H \cdot and \cdot O $_2$ H radicals are responsible, the relative importance of the reduction or oxidation process being determined by the substrate concentration. (auth)

17947 STUDIES ON MUTATIONS INDUCED BY NON-LETHAL DOSAGES OF ULTRAVIOLET LIGHT. D. M. Shankel and O. Wyss (Univ. of Texas, Austin). *Radiation Research*, 14: 605-17 (May 1961).

The dose range of nonlethal but mutagenic ultraviolet light was delineated for the streptomycin-resistance locus (loci) in *E. coli* B/r. The nonlethal system described is unique in its response to nutrition during the period of phenotypic expression and in the time required for "fixation" or "stabilization" of the mutant factor(s). No nutritional response occurs when the streptomycin-resistant mutants are induced by dosages of ultraviolet that are lethal to a large portion of the population. Preliminary investigations with chloramphenicol indicate that both protein synthesis and synthesis of other nuclear components are required for the "fixation" and expression of part of the induced mutations. Preliminary work with metabolite analogs suggests the possibility that the numbers of mutants to be expressed may be increased or decreased by use of the appropriate analog. Ultraviolet light is postulated to have two mechanisms of action: It produces, perhaps by direct effect, mutants which are not modified by postirradiation nutrition, and, in addition, it produces mutants which are subject to modification by appropriate postirradiation treatment. Presumably the latter are due to an indirect effect of the irradiation. (auth)

17948 CELLULARITY AND DEOXYRIBONUCLEIC ACID SYNTHESIS IN BONE MARROW AFTER TOTAL- AND PARTIAL-BODY IRRADIATION. A. Tsuya, V. P. Bond, T. M. Flidner, and L. E. Feinendegen (Brookhaven National Lab., Upton, N. Y.). *Radiation Research*, 14: 618-32 (May 1961).

Rats were exposed to 600 r, and the cellularity, cytology, and ability to synthesize DNA by using H 3 -thymidine and autoradiography were studied in the erythroid precursors over the first 24 hours after exposure. The loss of red cell precursors was early and profound, most marked in the younger forms. The number of cells capable of being labeled during DNA synthesis in all maturation compartments decreased considerably more rapidly than did the total number of similar cells, or the number of similar cells not in DNA synthesis. Some of the marked effect on DNA-synthesizing ability was due to an inhibition or to a decreased rate of the actual process of DNA synthesis as indicated by reduced grain counts. However, some was probably due to normal movement of cells out of the DNA synthesis phase, with failure of replacement due to cell death and/or delay of cells entering DNA synthesis. Effects of the exposure on the number of mitotic figures and on cytology are described. A slight and transient effect in shielded bone marrow on the number of labeled cells, the grain count, and the number of mitotic figures was observed. (auth)

17949 RADIATION INJURY RESULTING FROM NUCLEAR LABELING WITH TRITIATED THYMIDINE IN THE CHICK EMBRYO. Mary Elmore Sauer and Bruce E. Walker (Univ. of Texas, Medical Branch, Galveston). *Research Radiation*, 14: 633-42 (May 1961).

Two- to three-day old chick embryos were treated with thymidine-H 3 (10 to 50 μ c per embryo; specific activity 1.6

or 1.9 curies per millimole) through a window in the shell, and incubation was continued for 12 to 55 hours longer. All embryos incubated after treatment for 12 hours or longer displayed cytological changes characteristic of radiation injury. Injury could be avoided and satisfactory radioautographs still obtained by diluting the thymidine- H^3 one hundred to five hundred times with unlabeled thymidine, thus reducing the specific activity to 4 to 20 $\mu\text{Ci}/\mu\text{M}$. (auth)

17950 THE RELATIONSHIP OF THE METABOLIC STATE OF DEOXYRIBONUCLEIC ACID DURING X-IRRADIATION TO HeLa S3 GIANT CELL FORMATION. R. B. Painter, V. W. R. McAlpine, and M. Germanis (Battelle Memorial Inst., Columbus, Ohio). *Radiation Research*, 14: 653-61 (May 1961).

The probability of giant cell formation as a function of the position of the cell in the DNA metabolic cycle at time of x-irradiation was examined by autoradiographically determining the retention of labeled cells in irradiated populations. It was found that the frequency of labeled giant cells in the population at times of 1 to 5 weeks after irradiation is practically the same as at time zero, regardless of whether the great majority of the labeled cells are in DNA synthesis at the time of irradiation or in the phases before or after DNA synthesis. A tendency, in some experiments, for cells in synthesis at the time of irradiation to be slightly more capable of forming giant cells may indicate that these cells are somewhat less likely to undergo the abortive mitotic action which leads to lytic death in these cultures. (auth)

17951 THE EFFECT OF WHOLE-BODY X-IRRADIATION ON THE PASSAGE AND ABSORPTION OF STRONTIUM AND CALCIUM IN THE GASTROINTESTINAL TRACT OF THE RAT. F. W. Lengemann and C. L. Comar (New York State Veterinary College, Cornell Univ., Ithaca). *Radiation Research*, 14: 662-7 (May 1961).

Young male albino rats (100 to 120 gm) were exposed to 285-kvp x rays for 10 minutes at a dose rate of 40 r/min. At various times after irradiation, they were given a dose of Sr^{85} and Ca^{45} into ligated segments of the small intestine to ascertain the effect of irradiation on absorption. At 2 hours after irradiation, the only change noted was a possible depression of absorption in the duodenum. At 16 hours no effect was noted. At 24 hours, an increased permeability of the ileum and jejunum to both Ca^{45} and Sr^{85} was seen. The effect was present in the ileum at 48 hours for both Ca^{45} and Sr^{85} but only for Ca^{45} in the jejunum. Evidence was obtained that at 2 hours after irradiation the movement of the test solution out of the stomach and along the small intestine was at a slower rate than for the controls. This appeared to explain the increased absorption of Sr^{85} seen at a similar time period with intact rats. At 48 hours after irradiation, the movement of the test dose from the stomachs of the irradiated rats was faster than for the control rats. However, a slower movement through the small intestine was detected. This accentuated the increased permeability seen in the ileum. (auth)

17952 RADIATION SENSITIVITY OF *TRADESCANTIA* MICROSPORE CHROMOSOMES TO A SECOND EXPOSURE OF X-RAYS. Karl Sax (Yale Univ., New Haven). *Radiation Research*, 14: 668-73 (May 1961).

Tradescantia microspores were irradiated with 400 r of x rays and 2 days later with 50, 70, or 100 r. The cells were fixed and stained 23 to 27 hours after the second exposure. The first exposure produced only chromosome aberrations, and the second exposure produced only chromatid aberrations. The frequency of cells with chromatid aberrations in the cells which had been subjected to 400 r

of x rays was much higher than in cells which had received only 50, 70, or 100 r, indicating that the irradiation of the cells at the resting stage made the chromosomes more sensitive to irradiation at prophase. Irradiation at the early resting stage resulted in some increase in chromosome aberration frequency by the second dose given at the late resting stage, but the results are of doubtful statistical significance. An analysis of microspores which had been given 400 r followed by 50, 70, or 100 r shows that the cells with no chromosome aberrations induced at the resting stage were twice as sensitive to irradiation at prophase as the cells which contained one or more chromosome aberrations which had been induced at the resting stage, and microspores with only one chromosome aberration were more sensitive to irradiation at prophase than microspores with two chromosome aberrations, although all cells had been subjected to 400 r of x rays at the resting stage. (auth)

17953 DWARFISM AND EYE ABNORMALITY IN X-IRRADIATED RAT POPULATIONS. J. F. McGregor and H. B. Newcombe (Atomic Energy of Canada Ltd., Chalk River, Ont.). *Radiation Research*, 14: 674-80 (May 1961).

The frequency of dwarfism in rat populations is shown to be correlated with the radiation exposure accumulated over successive generations. In some instances the dwarf character is associated, either in the same animal or in the same pedigree, with eye defects and other abnormalities. Roughly 400 r (accumulated exposure to the male lines in closed populations) are required to double the incidence of dwarfism, and the observed increase is equal to approximately one case per 10^5 population per roentgen. (auth)

17954 RADIOSENSITIVITY OF SEEDS. II. EFFECTS OF SOAKING, STORAGE, AND GAMMA RAYS. Philip E. Hoskinson and Thomas S. Osborne (Univ. of Tennessee, Knoxville and UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.). *Radiation Research*, 14: 681-8 (May 1961).

Barley grains received Co^{60} γ rays after various periods of aerobic soaking and storage. Treatment combinations totaled 126 and were replicated four times. Effects were measured by germination and seedling height, 11 days from the start of treatment. Soaking without irradiation caused no significant injury unless prolonged for 24 hours. In the 10,000-r treatments, with 1 to 4 hours of soaking, sensitivity increased until 7 hours' preirradiation storage and decreased with longer storage periods. Similar changes of sensitivity occurred in the 2000-r treatments after longer periods of soaking and storage. The spectacular decline of sensitivity during storage in these instances was attributed to interruption of the rapid increase in metabolic rate as water became limiting. (auth)

17955 IMMUNITARY VARIATIONS IN ANIMALS IRRADIATED IN HIBERNATION. III. THE BACTERICIDAL POWER. A. Billitteri, M. Girlando, and G. Gasso (Università, Cantania, Italy). *Radiobiol. latina*, 3: 107-11 (Apr.-June 1960). (In Italian)

Artificial hibernation decreases the reduction in the bactericidal power of the serum in animals irradiated at normal body temperature. This finding can be related to the fact that in animals irradiated during hibernation neither the gamma globulin nor the complement activity shows any diminution. (auth)

17956 EFFECTS OF FRACTIONATED IRRADIATION ON THE LATERO-CERVICAL LYMPH NODES IN GUINEA PIGS. MORPHOLOGICAL AND HISTOCHEMICAL RESEARCH. E. Turolla, A. Trenta, and G. Aliprandi (Uni-

versità, Pavia, Italy). *Radiobiol. latina*, 3: 113-26 (Apr.-June 1960). (In Italian)

The left cervical lymph nodes were irradiated in young guinea pigs, using fractionated doses of 500 to 12000 r. Animals were sacrificed immediately and 15 and 30 days after irradiation. The initial damage and the repair processes were studied morphologically with the aid of histochemical techniques. Within the experimental limits, and even after the highest doses, a complete disappearance of the lymphatic tissue was never seen, in contrast to the reports of other authors. Moreover the reticular cells never appeared damaged and never showed any signs of fibroblastic transformation, whereas this was evident in the capsule and pericapsular tissue. On the other hand signs of a lymphoblastic differentiation of reticular cells were clearly seen. (auth)

17957 IMMUNITARY VARIATIONS IN ANIMALS IRRADIATED IN HIBERNATION. IV. THE BEHAVIOR OF LYSOZYME. A. Bernardini, A. Billitteri, and G. Gasso (Università, Catania, Italy). *Radiobiol. latina*, 3: 129-36 (Apr.-June 1960). (In Italian)

X irradiation of the guinea pig considerably reduces the lysozyme content of the lung and spleen. If the irradiation is performed during hibernation the diminution is more pronounced. Hibernation itself reduces the lysozyme content of the organs studied. (auth)

17958 METABOLIC VARIATIONS IN ANIMALS IRRADIATED IN HIBERNATION. III. MODIFICATIONS OF THE HEMATOLOGICAL PICTURE. A. Billitteri and G. Gasso (Università, Catania, Italy). *Radiobiol. latina*, 3: 137-47 (Apr.-June 1960). (In Italian)

Hematological changes in guinea pigs irradiated during hibernation were studied. As regards red cells they found a less severe anemia, and similarly a less pronounced anisocytosis and poikilocytosis. As regards white cells they found a less severe leucopenia with relative neutrophilia. Artificial hibernation not only reduces the amount of hematological damage, but also retards its appearance. (auth)

17959 THE BEHAVIOR OF THE SEROUS ELECTROLYTES (SODIUM-POTASSIUM-CHLORINE) IN CANCERS EXPOSED TO IRRADIATION. Renato Sorrentino (Ospedale Maggiore, Novara, Italy). *Radiobiol. latina*, 3: 157-75 (Apr.-June 1960). (In Italian)

As the results reported on the electrolytic disturbances during radiation treatment do not agree, the results of new studies on the behavior of sodium, potassium, and chlorine in cancer patients during irradiation are reported. The relations between the electrolytic changes and radiation sickness are determined. (auth)

17960 THE RADIOSENSITIVITY OF THE RENAL PARENCHYMA. U. Nuvolone (Università, Messina, Italy). *Radiobiol. latina*, 3: 177-90 (Apr.-June 1960). (In Italian)

A review is given of studies made on the radiosensitivity of the renal parenchyma, beginning with reports published in 1906. (J.S.R.)

17961 EFFECT OF ABDOMINAL SHIELDING ON THE METABOLISM OF HYDROCORTISONE BY LIVER TISSUE OF X-IRRADIATED RATS. James R. Lott (North Texas State Coll., Denton). *Texas J. Sci.*, 13: 57-60 (Mar. 1961).

Liver slices removed from adult rats at various times following whole body x-irradiations of 850, 1500, and 2000 r were tested for their ability to metabolize hydrocortisone (free alcohol). The animals were divided into a non-irradiated control group, an irradiated unshielded group, and an abdominal-shielded irradiated group. It was found that the irradiated unshielded liver slices metabo-

lized the hydrocortisone at a lower rate than control slices. Liver slices removed from animals whose abdominal regions were shielded during irradiation were found to metabolize hydrocortisone at a higher rate than control slices. The effects observed appeared to be dependent on total dosage and time of removal of the liver post-irradiation. (auth)

Radiation Sickness

17962 (JPRS-7975) PROBLEMS OF MORPHOLOGY DISCUSSED AT THE SCIENTIFIC CONFERENCE ON THE PROBLEM OF "THE RESTORATIVE AND COMPENSATORY PROCESSES IN RADIATION SICKNESS." I. A. Chalisov. Translated from *Ark. Anat. Gistol. i Embriol.*, 34: No. 11, 121-4 (Nov. 1960). 10p.

Pathological effects of radiation and problems involved in the prevention and treatment of radiation sickness are discussed. The importance of regenerative processes in the irradiated organism is stressed. Results are summarized from a number of studies which demonstrate the ability of various tissues to regenerate after radiation injury. (C.H.)

17963 THE RESTORATION OF MUSCLES, WHICH HAVE BEEN INJURED BY X-RAYS, AFTER TREATING WITH PULVERIZED MUSCLE TISSUE. Hsiu-pi Wang (Severtsov Inst. of Animal Morphology, Academy of Sciences, USSR). *Doklady Akad. Nauk S.S.S.R.*, 137: 735-8 (Mar. 21, 1961). (In Russian)

Forty white rats were irradiated on both extremities with a single x-ray dose of 2000 r. A transverse cut was made on each extremity one day after the irradiation. One cut was not treated any further, while the other cut was infused with pulverized muscle tissue. The regenerative changes were followed by staining techniques. The cut treated with muscle tissue healed faster than the untreated cut. The degenerative process is stopped more rapidly in the treated cut. There is an intensive development of new muscle tissue in the treated cut. Part of the pulverized muscle fragments are viable, and can participate in the regenerative process. The amount of RNA in the treated cut was observed to increase more rapidly than in the untreated cut. (TTT)

17964 ESTROGEN RADIOPROTECTION IN MICE. Wendell H. Rooks, II, and Ralph I. Dorfman (Worcester Foundation for Experimental Biology, Shrewsbury, Mass.). *Endocrinology*, 68: 838-43 (May 1961).

The radioprotective effect of estradiol-17 β was studied using 20-day-old male Swiss mice which were injected subcutaneously with the test material, dissolved in sesame oil, once daily for the 10 days prior to an LD₅₀ dose of Co⁶⁰ irradiation at 30 days of age. Total doses of 10 and 20 μ g of estradiol-17 β afforded significant protection up to 35 days post-irradiation. Similar protection was produced by a single injection of 165 μ g of estradiol-17 β benzoate administered 10 days before irradiation. (auth)

17965 THE DIAGNOSIS OF CHRONIC RADIATION SICKNESS. G. I. Dorofeev and B. A. Onikienko (Kirov Military Medical Academy). *Med. Radiol.*, 6: No. 1, 9-12 (Jan. 1961). (In Russian)

Dynamic investigations were made of the blood protein fractions by means of paper electrophoresis in 14 employees of the radiological department who for a protracted period of time (7 to 9 years) were in contact with radioactive substances (mesothorium, Co⁶⁰). A conclusion was made to the effect that studies of the blood protein fractions could be instituted as a supplementary test for the diagnosis of chronic radiation sickness and for evaluation of the results of treatment. (auth)

17966 ANTIBODY FORMATION IN WORKERS OF ROENTGEN DEPARTMENTS VACCINATED WITH LIVE TULAREMIA VACCINE. B. B. Marder. *Med. Radiol.*, 6: No. 1, 13-15 (Jan. 1961). (In Russian)

Workers of roentgenological departments, physicians, roentgen technicians and auxiliary personnel (a total of 15 persons) were immunized by the percutaneous method with live tularemia vaccine. For comparison, subject to immunization were 5 medical workers not working in roentgenological departments. In all the persons immunized blood was taken 1, 2, 3 months and one year after the vaccination for studies of the agglutination titers of sera. The lowest antibody titer was seen in roentgen technicians, whereas the highest—in auxiliary personnel and the controls. (auth)

17967 THE INTENSITY OF RADIOPHOSPHORUS INCLUSION INTO ERYTHROCYTES IN CHRONIC ACTION OF IONIZING RADIATION. P. A. Rozenberg and M. I. Smirnova (Inst. of Labor Sanitation and Occupational Disease, Academy of Medical Sciences, USSR). *Med. Radiol.*, 6: No. 1, 23-5 (Jan. 1961). (In Russian)

A study was made of the intensity of radiophosphorus inclusion into erythrocytes in chronic effects of ionizing radiation. (auth)

17968 TRANSPLANTATION OF HOMOLOGOUS BONE MARROW IN DOGS AND MONKEYS AFFECTED WITH ACUTE RADIATION SICKNESS. A. A. Bagdasarov, G. V. Sukasyan, M. N. Novikova, and M. O. Raushenbakh (Central Order of Lenin Inst. of Hematology and Blood Transfusion, Ministry of Public Health, USSR). *Med. Radiol.*, 6: No. 1, 26-34 (Jan. 1961). (In Russian)

Under study was the course of acute radiation reaction in dogs and monkeys during the transfusion of homologous bone marrow. The investigations have shown that transfusion of the bone marrow in experiments staged on large animals alleviates the course of acute radiation sickness. The successfulness of the transplantation was judged by the rise in the peripheral blood of the number of leukocytes, thrombocytes and reticulocytes, by the restoration of the cellular composition of the bone marrow and the survival rate of the animals in comparison with the controls. Bone marrow transfusion testifies to the positive effect of this biological mode of protection in acute radiation sickness. (auth)

17969 THE STATE OF LYMPHATIC PATHS IN ACUTE RADIATION SICKNESS ACCORDING TO DATA OF INTRAVITAL LYMPHOGRAPHY. Ya. B. Mittelberg (Kazan State Scientific Research Inst. of Traumatology and Orthopedics, Ministry of Public Health, USSR). *Med. Radiol.*, 6: No. 1, 34-6 (Jan. 1961). (In Russian)

The state of lymphatic paths in acute radiation sickness was assessed by means of a filtered bundle of x-rays with a total dose of 800 r. Experiments were staged on dogs. It was disclosed that in acute radiation sickness, notwithstanding progressive disorders of lymphatic paths with impeded lymph outflow, no formation of collateral lymphatic routes is observed. The absence of this adaptive reaction is due to the severe injurious effect of roentgen rays in the referred to dose. (auth)

17970 THE INFLUENCE OF THE SEASONAL PREVALENCE ON THE INJURIOUS EFFECT OF IONIZING RADIATION. N. A. Volokhova. *Med. Radiol.*, 6: No. 1, 41-8 (Jan. 1961). (In Russian)

In experiments on rabbits subjected to gamma-irradiation (Co^{60} , doses 500 and 800 r) in different seasons of the year there were noted variations in the clinical manifestations of radiation sickness. Thus, the motor activity in the irradiated animals during the autumn-winter season decreases

to a greater extent than in summer. The thermoregulation in the irradiated animals during winter was at a lower level than in summer. When the conditions of irradiation were similar and the animals kept in the open air the irradiated rabbits survived for a longer time during winter than in summer. (auth)

17971 COMPARATIVE CHARACTERISTICS OF THE FERTILITY OF FIVE GENERATIONS OF MICE FROM IRRADIATED MALES. A. D. Proshina (Tomsk Medical Inst., USSR). *Med. Radiol.*, 6: No. 1, 41-8 (Jan. 1961). (In Russian)

Male white mice were subjected to the action of betatron radiation (25 Mev). Under study was the state of their progeny for a period of five generations. The results were assayed by the method of variation statistics. In the progeny of five generations there were established certain specific developmental features in contrast to the controls. In all generations the progeny was lesser in number. Stillbirth was the highest in the first generation. The weight of one-month-old mice was lower in all generations. The death rate of mice throughout the first month of life was highest in the first generation, particularly from males subjected to high doses of irradiation. The sterility of males was noted in all generations, however, in the first generation the percentage was the highest. Sterile females were encountered only in the first generation. Developmental abnormalities were observed in the first two generations and only from males subjected to large doses of irradiation. (auth)

17972 THE EXCRETION OF DISCHE-POSITIVE COMPOUNDS FROM THE ORGANISM DURING THE EMPLOYMENT OF SUBSTANCES OF CHEMICAL PROTECTION FROM THE ACTION OF IONIZING RADIATION. E. F. Romantsev and Z. I. Zhulanova. *Med. Radiol.*, 6: No. 1, 49-52 (Jan. 1961). (In Russian)

It was demonstrated that L-cysteine, β -mercaptoethylamine, 2-iminothiazolidine, N-morpholinylcysteamine, ethylaminoisothiuronium, azidodithiocarbonic acid, administered in quantities causing a protective action, produce an insignificant but constant lowered excretion of Dische-positive compounds with the urine in the irradiated rats. An analogous effect was noted during the irradiation of rats in an atmosphere with a reduced content of oxygen (10%). (auth)

17973 THE EFFECT OF IONIZING RADIATION ON PREGNANCY AND FETAL DEVELOPMENT. N. M. Pobedinskii. *Med. Radiol.*, 6: No. 1, 72-80 (Jan. 1961). (In Russian)

A review is presented on the reactions of pregnant animals to radiation, the effect of ionizing radiation on the fetus and offspring of man and animal, the mechanism of the action of ionizing radiation on the fetus, and the protective action of agents such as mercamine and heroin. It is stressed that the effect of a dose of ionizing radiation varies with the stage of pregnancy at the time of irradiation (80 references). (TTT)

17974 MORPHOLOGICAL BLOOD CHANGES AS AN EARLY REACTION TO RADIATION. L. B. Yuskevich. *Med. Radiol.*, 6: No. 1, 82-3 (Jan. 1961). (In Russian)

The changes in blood composition were investigated in a group of 132 people (79 men and 53 women), most of whom had been working with radioactive isotopes for less than 5 years. A shift of the blood formula to the right is assumed because of the large number of hypersegmented neutrophilic forms observed. Gemmate neutrophils were observed in 70 people (53%), hyperfragmented neutrophil nuclei (number of segments > 5) in 33 people (24%) and

chromatinolysis in 4 people (3%). A longer bleeding time (4 to 24 minutes) in almost one-half the people was simultaneously accompanied by a decrease in thrombocytes. There was a general tendency to an increase in blood count of various cells in these people who had been subjected continuously to small doses of ionizing radiation. (TTT)

17975 THE PROTECTIVE ACTION OF N-DERIVATIVES OF β -MERCAPTOETHYLAMINE FROM THE HARMFUL EFFECTS OF PENETRATING RADIATION. L. I. Tank. *Med. Radiol.*, 6: No. 1, 85-6 (Jan. 1961). (In Russian)

The survival after 30 days was taken as a criterion of the protective action of 24 N-derivatives of β -mercaptoethylamine administered to mice which had been given a lethal dose of Co^{60} gamma radiation or of x-rays. Neither the water-soluble nor the fat-soluble compounds were as effective as β -mercaptoethylamine itself which protected 60% of the irradiated mice from death. Derivatives of ortho-toluidine and ortho-anisidyl gave protection when introduced 3 hours before irradiation, whereas β -mercaptoethylamine affords protection for only 30 minutes after injection. Most of these N-derivatives are more toxic than β -mercaptoethylamine. (TTT)

17976 THE EFFECT OF CERTAIN ANTICHOLINESTERASE PREPARATIONS ON THE COURSE AND OUTCOME OF RADIATION SICKNESS. M. M. Lenkevich. *Med. Radiol.*, 6: No. 1, 86-7 (Jan. 1961). (In Russian)

Experiments on 5000 mice irradiated with a dose of 600 to 800 r showed that octaethyltetramide pyrophosphoric acid had the greatest effect on survival ($64 \pm 14\%$ survival compared to 40 to 50% for mercaptoamine under the same conditions). Phosarbine (dose of 0.01 mg/kg) enabled dogs irradiated with 600 r to recover, and even to take another dose of 600 r and recover. The control dogs died on the 11th and 15th day after irradiation. The protective action of these organic phosphorous compounds is due to their anticholinesterase action. (TTT)

17977 SPECIAL FEATURES OF THE ESTABLISHMENT OF THE HEMATOPOIETIC FUNCTION IN DOGS AFTER RECEIVING BURNS COMPLICATED BY IONIZING RADIATION. A. L. Komendantova, E. A. Khrushcheva, and K. V. Botsmanov. *Med. Radiol.*, 6: No. 1, 84-5 (Jan. 1961). (In Russian)

The trauma due to burns in dogs irradiated with 600 r is accompanied by leukocytosis, neutrophilia, and a neutrophilic shift to the left within a few days. The leukocytosis increases with time. These deviations in the blood picture are maintained for a protracted period of time. (TTT)

17978 PROTECTIVE EFFECT OF ORALLY ADMINISTERED S, β -AMINOETHYLISOTHIURONIUM. Br. HBr AGAINST X-RADIATION DEATH IN MICE. M. P. Dacquisto and E. W. Blackburn (Walter Reed Army Medical Center, Inst. of Research, Washington, D. C.). *Nature*, 190: 270 (Apr. 15, 1961).

Orally administered S, β -aminoethylisothiuronium • Br • HBr exerted a significant protective effect against radiation death in mice when doses of 1500 mg/kg were given 2, 3, and 5 hr before lethal doses of x radiation. Data are

tabulated on the 30-day mortality of treated mice after exposure to doses of 770 r whole-body radiation. (C.H.)

17979 EXPERIMENTAL STUDY ON THE EVENTUAL PROTECTIVE ACTION OF ROYAL JELLY ON THE CUTANEOUS LESIONS FROM IRRADIATION. A. Trenta, A. Giordano, and M. Caprotti (Università, Pavia, Italy). *Radiobiol. latina*, 3: 149-54 (Apr.-June 1960). (In Italian)

Following a previous study of the radioprotective action of royal jelly given by mouth, its protective action when applied locally to skin reactions produced by x-ray therapy was studied. The results show no significant protective action under the conditions of the experiments. (auth)

17980 RESEARCH IN BIOLOGICAL RADIATION PROTECTION. REPORT XL. CHANGES IN AMINO ACID METABOLISM OF WHITE MICE FROM SUBLETHAL WHOLE-BODY IRRADIATION. Hanns Langendorff, Hans-Joachim Melching, and Christian Streffer (Universität, Freiburg i B.). *Strahlentherapie*, 114: 525-34 (Apr. 1961). (In German)

The change of elimination of tryptophan-metabolites and taurine in the urine of white mice as a result of sublethal whole-body-radiation was studied. The results allow one to conclude, that the disturbance of the pyridoxal-5-phosphate-system is of essential importance for the marking-out of the radiation-conditioned changes in the amino-acid metabolism. (auth)

17981 EFFECTS OF SUBLETHAL DOSES ON ORGANS OF HIGHER RADIOSENSITIVITY. Johannes Trautmann (Stadt. Krankenhaus Moabit, Berlin). *Strahlentherapie*, 114: 535-51 (Apr. 1961). (In German)

Some reactions of sublethal radiation on changing tissue are shown. Special attention is given to the radiation reaction on the female and male germinal glands, as also on the *in utero* developing embryo. Of special interest were the actions of germinal gland radiation on the F_1 -generation carried out shortly before fecundation and the damage produced on the embryo through doses less than 200 r. The urgency of these problems and the not yet sufficiently examined queries about them are pointed out. (auth)

17982 CAPILLARY SPROUTING AS REPARATION PRINCIPLE IN LOCAL RADIATION DAMAGE. Wolfgang Dihlmann, Gerhard Liebaltd, and Walter Undeutsch (Universität, Tübingen, Ger.). *Strahlentherapie*, 114: 552-64 (Apr. 1961). (In German)

In tests on radiated rabbit ears it could be shown, that the so-called capillary-sprouting ability has an important significance in the reparation of local post-radiation states and has a definite range (6 to 8 mm) for the rabbits. So far as the transference of our results to human beings is allowed, it is proved through the examinations, that the radiation chargeability of fields in these dimensions (single-field, grid-field) depends upon the charge of the scattered rays in the surrounding region, that is, so long as the sprouting ability of the capillaries of the surrounding region of the field is not narrowed through absorption of scatter rays, nearly unlimited doses of ionizing rays can be given upon such fields. In practice, the tele-cobalt grid radiation, for example, comes near to fulfilling these conditions. (auth)

CHEMISTRY

General and Miscellaneous

17983 (ANL-6287) CHEMICAL ENGINEERING DIVISION SUMMARY REPORT, OCTOBER, NOVEMBER, DECEMBER 1960. (Argonne National Lab., Ill.). Mar. 1961. Contract W-31-109-eng-38. 208p.

Chemical-metallurgical processing studies were made of pyrometallurgical development and research, and fuel processing facilities for EBR-II. Fuel-cycle applications of fluidization and volatility techniques included laboratory investigations of fluoride volatility processes, engineering-scale development, and conversion of UF_6 to UO_2 . Reactor safety studies consisted of metal oxidation and ignition kinetics, and metal-water reactions. Reactor chemistry investigations were conducted to determine nuclear constants and suitable reactor decontamination methods. Routine operations are summarized for the high-level gamma-irradiation facility and waste processing. (B.O.G.)

17984 (CF-61-2-32) EQUILIBRIUM ADSORPTION OF KRYPTON AND XENON ON ACTIVATED CARBON AND LINDE MOLECULAR SIEVES. R. D. Ackley and W. E. Browning, Jr. (Oak Ridge National Lab., Tenn.). Feb. 14, 1961. 12p.

Equilibrium krypton and xenon adsorption isotherms were obtained for four varieties of charcoal and for Linde Molecular Sieves Types 4A and 5A, generally at 0, 25, and 60°C. Such data are of interest in connection with design and evaluation of adsorbers for radioactive noble gas fission products. The isotherms were fitted, by linear regression analysis, to straight-line forms of the Freundlich and Langmuir equations. The Freundlich linear equation gave the better fit and the parameters of this equation are presented for each of the isotherms. Also presented are the constants for an equation representing the temperature dependence of arbitrary adsorption coefficients calculated from the Freundlich isotherm parameters. Some aspects of the applicability and accuracy of these results are discussed. (auth)

17985 (NP-10095) HIGH-TEMPERATURE SYNTHESIS OF NEW, THERMALLY-STABLE CHEMICAL COMPOUNDS. Report No. 12. Quarterly Progress Report No. 4, December 14, 1960-March 14, 1961. L. C. Bratt, D. L. Chamberlain, T. Mill, and C. W. Marynowski (Stanford Research Inst., Menlo Park, Calif.). Mar. 24, 1961. Contract AF33(616)-7245. 14p.

The electronically (r-f) activated reaction technique for synthesis of phosphonitrilic polymers was investigated and rejected because of unfavorable results. Pyrolysis of thiophosphoryl triamide at 500°C under vacuum was carried out on a large scale to provide a thermally and hydrolytically resistant product fraction sample for evaluation. The plasma jet flash pyrolysis apparatus for attempted conversion of halofluorocarbons to polymeric fluoro-organics was modified to eliminate possible contamination of products by water; nevertheless, the nonvolatile products were found to contain about the same levels of oxygen and hydrogen impurities as before. In the difluoroacetylene program, the results of two pyrolytic experiments are indefinite. Ferrocene monocarboxylic acid was synthesized in low yields. (D.L.C.)

17986 (NP-10123) URANIUM COMPOUNDS AS CATALYSTS IN SOLUTION POLYMERIZATION. Progress

Report No. 124.001, No. 40. E. Lasis (Polymer Corp. Ltd., Sarnia, Ont.). Dec. 1960. 10p.

Available patent literature was surveyed for the use of uranium compounds as catalysts for polymerizations of mono- and di-olefins. Only two concrete examples were found, both in K. Ziegler's patents and relating to the use of UCl_4 in the solution polymerization of ethylene; the other references to the use of uranium compounds are usually in the form of broad claims including other transition metals. However, one recent patent by Phillips Petroleum Co. tabulates numerous uranium salts. A bibliography of the patents reviewed is included. (D.L.C.)

17987 (NRL-5596) HYDROGEN OVERPOTENTIAL. PART 1. CHARACTERISTIC FUNCTIONS AND PARAMETERS IN THE THEORY OF HYDROGEN OVERPOTENTIAL. G. W. Castellan (Naval Research Lab., Washington, D. C.). Dec. 30, 1960. 19p.

The current density-overpotential relations for several possible mechanisms of hydrogen evolution reactions can be conveniently expressed in terms of one or the other of two characteristic functions: $g_1 = [e^{(\alpha - 1/2)\eta} \sinh \eta/2]i$, or $g_2 = \{(\tanh \eta/2)/i\}^{1/2}$, where i is the current density and η is the overpotential. The parameters α , ϕ_0 , i_0 , and ρ are found to be convenient, where α is defined as the transfer coefficient for the oxidation reaction; ϕ_0 is the fraction of the surface covered by H atoms at equilibrium; $i_0 = (di/d\eta)_{\eta=0}$; and $\rho = \{d \ln [\theta/(1-\theta)]/d\eta\}_{\eta=0}$. In the important special cases, the appropriate characteristic function (g_1 or g_2) is a simple function of the overpotential over the entire range of anodic and cathodic current values. The evaluation of the parameters involved in these special cases is considered. (auth)

17988 (OOR-1952:5) THE STRUCTURE OF OLEFIN-METAL COMPLEXES. Final Report, January 20, 1958-February 1, 1961. Norman C. Baenziger and J. R. Doyle (Iowa State Univ., Iowa City). Contract DA-11-022-ORD-2647. 10p.

Preparative procedures are presented for a large number of olefin-metal complexes, and results of diffraction studies are given for complexes of Ag, Pt, Fe, Cu, and Pd. (D.L.C.)

17989 (TID-12722) THERMODYNAMIC PROPERTIES AND ELECTRONIC ENERGY LEVELS OF EIGHT RARE EARTH SESQUIOXIDES (thesis). Bruce Hugo Justice (Michigan Univ., Ann Arbor). 1961. Contract AT(11-1)-70. 232p.

The heat capacities of 8 rare earth sesquioxides were measured over the range from 10 to 350°K. The sesquioxides of lanthanum and neodymium possessed an isomorphic hexagonal structure, samarium sesquioxide the B-type structure, and of the sesquioxides known to crystallize in the cubic phase, those of gadolinium, dysprosium, holmium, erbium, and ytterbium were determined. The lattice heat capacity of the hexagonal structures was approximated by the heat capacity of lanthanum sesquioxide and that for the isomorphic cubic structures below 100°K from the heat capacity of ytterbium oxide and above 100°K from the heat capacity of gadolinium oxide. Therefore the magnetic heat capacities of the sesquioxides of neodymium, gadolinium, dysprosium, holmium, erbium, and ytterbium were resolved from the knowledge of their isomorphic lattice heat capacities. The magnetic heat capacities above 10°K are characterized by Schottky anomalies which were

correlated to the energy levels created by the crystalline electric fields in these oxides. A summary of these levels is presented. Below 10°K there is evidence that the Schottky heat capacity is accompanied by contributions from magnetic coupling leading to cooperative transitions in the heat capacity. The thermodynamic functions were computed with respect to different reference states, but in all cases the values excluded increments due to nuclear spin and isotope mixing. The extrapolation of heat capacity to absolute zero was estimated for all the sesquioxides. The resulting molal entropies at 298.15°K along with the increment due to the extrapolation of the heat capacity are summarized. (auth)

17990 (UCRL-Trans-658(L)) A POLAROGRAPHIC STUDY OF THE REDUCTION OF THE CHLOROIRIDATE-ION ON A PLATINUM ELECTRODE. N. K. Pshenitsyn, N. A. Ezerskaya, and V. D. Ratnikova. Translated from Zhur. Neorg. Khim., 3: 1791-8(1958). 17p.

The polarographic behavior of Ir(IV) on rotating Pt electrodes was found to be uniform and applicable to the determination of small quantities of Ir in solution. The substances studied were H_2IrCl_6 , K_2IrCl_6 , $\text{K}_3\text{IrCl}_6 \cdot \text{H}_2\text{O}$, and $\text{K}_2[\text{IrCl}_5\text{H}_2\text{O}]$ in solutions of NaCl and NaNO_3 of various concentrations. The pH dependence on the half-wave potential and absorption spectra of K_2PtCl_6 indicate that, when pH is increased, $[\text{IrCl}_6]^{2-}$ hydrolyzes to form products of lower diffusion coefficient. Studies of the mechanism of $[\text{IrCl}_6]^{2-}$ reduction show that the reduction product also hydrolyzes, probably forming $[\text{IrCl}_5\text{H}_2\text{O}]^{2-}$. The diffusion coefficient of Ir(IV) is proportional to its concentration. With this polarographic technique, Ir can be determined in the presence of Rh, Pt, Pd, and other impurities. (D.L.C.)

17991 USE OF SUBSTITUENT EFFECTS ON ISOTOPE EFFECTS TO DISTINGUISH BETWEEN PROTON AND HYDRIDE TRANSFERS. PART I. MECHANISM OF OXIDATION OF ALCOHOLS BY BROMINE IN WATER. C. Gardner Swain, Robert A. Wiles, and Richard F. W. Bader (Massachusetts Inst. of Tech., Cambridge). J. Am. Chem. Soc., 83: 1945-50(Apr. 20, 1961).

Differences between proton and hydride transfers are discussed. Theoretical reasons are given for expecting k_H/k_D isotope effects to increase markedly on introduction of electron-attracting substituents for proton transfers, but to be much less sensitive to substituents for hydride transfers. Experimental data support this conclusion. Therefore it is applied as a tool for distinguishing between proton and hydride transfers in the oxidation of 0.01 to 0.2 M 2-propanol by 0.001 to 0.008 M bromine in water solution at 50°. This reaction is first order in each reactant, independent of bromide ion and acidity from pH 1 to 3, and exhibits CH and OH isotope effects of 2.94 and 1.49. These results exclude a hypobromite intermediate. The oxidation of 1-fluoro-2-propanol is kinetically similar but exhibits CH and OH isotope effects of 2.83 and 2.06. These changes in isotope effect are inconsistent with a proton transfer from carbon and a hydride transfer from oxygen, but consistent with a hydride transfer from carbon and a proton transfer from oxygen. (auth)

17992 USE OF SUBSTITUENT EFFECTS ON ISOTOPE EFFECTS TO DISTINGUISH BETWEEN PROTON AND HYDRIDE TRANSFERS. PART II. MECHANISM OF DECARBOXYLATION OF β -KETO ACIDS IN BENZENE. C. Gardner Swain, Richard F. W. Bader, Ramon M. Esteve, Jr., and Richard N. Griffin (Massachusetts Inst. of Tech., Cambridge). J. Am. Chem. Soc., 83: 1951-5(Apr. 20, 1961).

Isotope effects ($k_{\text{RCOOH}}/k_{\text{RCOOD}}$) in the decarboxylation

of substituted benzolacetic acids in benzene at 50° are 2.8 for *m*-nitro, 1.7 for *p*-chloro, 1.4 for unsubstituted, and 0.85 for *p*-methyl, although these substituents have a negligible effect on OH frequencies in the ground state. This large variation in isotope effect with substituents is inconsistent with a cyclic hydride transfer mechanism but in accord with a cyclic proton transfer mechanism. (auth)

17993 COMPLEXING OF YTTRIUM. I. YTTRIUM OXINATES. M. G. Panova, V. I. Levin, and N. E. Brezhneva. Radiokhimiya, 2: 197-207(1960). (In Russian)

The extraction of yttrium from 3 M perchlorate solution by oxine in chloroform was studied, and a method was developed for determining distribution coefficients without interference from hydrolysis. Concentrations of yttrium in the aqueous phase ($<10^{-6}$ M) are extracted as ordinary YA_3 oxinate, while the dimer $(\text{YA}_3)_2$ is extracted at higher concentrations. The extracted complex contains about 0.5 non-dissociated oxine. The extraction method is used for determining the yttrium oxinate complex stability constants: $\log \kappa = 8.15 \pm 0.14$, $\log \kappa_2 = 14.90 \pm 0.25$, $\log \kappa_3 = 20.25 \pm 0.35$. It is shown that a graphical method of two parameters produces results close to those obtained by the method of least squares. (R.V.J.)

17994 COMPLEXING OF YTTRIUM. II. SULFATE, NITRATE AND CHLORIDE COMPLEXES. M. G. Panova, N. E. Brezhneva, and V. I. Levin. Radiokhimiya, 2: 208-14(1960). (In Russian)

Quantitative complexing of yttrium in solution was determined by measuring the equilibrium between two liquid phases (oxine solution in chloroform-aqueous solution). A new variation of the "two parameter method" was developed for measuring complexing constants. The constants for yttrium complexing with sulfate, chloride, and nitrate ions at a constant ionic strength of $\mu = 3.0$ were determined. (R.V.J.)

17995 COMPLEX COMPOUNDS OF SCANDIUM CHLORIDE WITH O-PHENANTHROLINE, $\alpha\alpha'$ -DI-PYRIDYL AND $\gamma\gamma'$ -DIPYRIDYL. B. N. Ivanov-Emin, L. A. Nisel'son, and L. A. Larionova. Zhur. Neorg. Khim., 6: 334-6(1961). (In Russian)

Synthesized complexes of ScCl_3 with o-phenanthroline, $\alpha\alpha'$ -dipyridyl, and $\gamma\gamma'$ -dipyridyl ($\text{ScCl}_3 \cdot 3 \text{ Phn}$, $\text{ScCl}_3 \cdot 2 \alpha\alpha' \text{ Dip}$, and $\text{ScCl}_3 \cdot 2 \gamma\gamma' \text{ Dip}$) were analyzed. The electric conductivity of these complexes indicates that the complex compounds are quaternary and dissociate according to the scheme: $[\text{Sc} \cdot \text{Phn}] \text{Cl} \rightarrow [\text{Sc} \cdot 3 \text{ Phn}]^{3+} + \text{Cl}^-$. The pH values for various concentrations were determined. (R.V.J.)

17996 PROCEEDINGS OF THE JOINT SYMPOSIUM ON INSTRUMENTATION & COMPUTATION IN PROCESS DEVELOPMENT AND PLANT DESIGN, LONDON 11-13 MAY 1959. P. A. Rottenburg, honorary ed. London, The Institution of Chemical Engineers, 1960. 179p. £4.

Eighteen papers are included; separate abstracts have been prepared for two. Papers not abstracted separately covered information on process efficiency improvement, process control systems, application of on-line computers, design and use of analogue computers, and the use of computer techniques in large and small companies. (N.W.R.)

17997 IMPROVEMENTS IN AND RELATING TO POLYMERIZATION. (to E. I. du Pont de Nemours and Co.). British Patent 866,768. May 3, 1961.

A process is given for polymerization of vinyl compounds, in the presence of irradiated refractory compounds. The refractory compounds are preferably oxides such as alumina, zirconia, or silica, but silicates such as aluminum silicate may also be used. The refractory compound is ex-

posed to ionizing radiation with an energy greater than 0.1 Mev until 0.1 to 1500 watt sec/g energy is absorbed. The irradiated compound is then contacted with the vinyl compound in vapor or liquid phase in an inert atmosphere. (T.F.H.)

17998 IMPROVEMENTS IN THE TREATMENT OF POLYETHYLENE AND LIKE POLYOLEFINS. (to W. R. Grace & Co.). British Patent 866,819. May 3, 1961.

A technique is described for producing permanent transparency in polyethylene and similar crystallizable polyolefins. The polymer is heated above its transition temperature and is rapidly quenched. The temporary transparency of the polymer is made permanent by an irradiation dose of about 50 to 75 Mrep. The polymer can be remoulded after irradiation with no appreciable transparency loss. (T.F.H.)

Analytical Procedures

17999 (AE-54) A CHEMICAL EIGHT GROUP SEPARATION METHOD FOR ROUTINE USE IN GAMMA SPECTROMETRIC ANALYSIS. I. ION EXCHANGE EXPERIMENTS. K. Samsahl (Aktiebolaget Atomenergi, Stockholm). 1961. 13p.

A method for the separation of chemical elements in 8 groups suitable for gamma spectrometric analysis was developed. One group of elements is separated by distillation during dissolution of the sample. The other groups are obtained by means of short ion exchange columns coupled in series. An anion exchange column saturated with chloride ions separates chloride complexes, peroxides, and other anions from a 3 N HCl + 0.3% H₂O₂ sample solution. Some of the chloride complexes are eluted with 0.1 N HCl + 0.3% H₂O₂ and subsequently adsorbed as cations on a cation exchange column in hydrogen form. A few eluted elements which do not form cations in this case are found in the effluent. Elements passing the anion exchange column in chloride form without adsorption are separated from a H₂O solution as citrate complexes, hydroxides, cations, and hexametaphosphate complexes. This is done by coupling in series two anion exchange columns subsequently in citrate and hydroxide form and followed by a cation exchanger in sodium form. A mixed bed column ends the series. The behavior in the separation series of most elements forming gamma emitting isotopes with half lives exceeding 10 minutes on irradiation with thermal neutrons was studied. (auth)

18000 (AFCRC-TR-60-276) MASS SPECTROMETRIC INVESTIGATION. Technical (Final) Report, July 1957–April 1960. Wilhelm L. Groth. Includes paper: MASS SPECTROMETRIC INVESTIGATIONS BY MEANS OF A FIELD EMISSION ION SOURCE. H. D. Beckey (Bonn. Universitat, Institut für Physikalische Chemie). Contract AF61(514)-1079. 42p. (AD-245445)

A new method was developed for mass spectrometric detection of short-lived primary products of photochemical reactions. A field emission ion source was developed at which the diverging ion bundle which is formed at a tungsten tip at field strengths of 1 to 5 × 10⁸ v/cm is focused on the entrance slit of a mass spectrometer. The photochemical decomposition of the acetone by the light of the 2537 Å wavelength was investigated. The association of water was investigated, and at room temperature polymers of the water up to the tetramer, H₃O⁺ · (H₂O)₃, were found. Ion-molecule reactions of type CH₃OH⁺ + CH₃OH → CH₃OH₂⁺ + CH₃O were investigated in dependence on the field strength, and reaction mechanism was discussed. The CH₃CO radical formed by chemisorption of methanol on tungsten was de-

tected in the field emission mass spectrum. A second type of field-emission ion source was developed, where the ion optic was improved and which can be used for investigations at low temperatures. The association of water at the temperature of liquid nitrogen was also investigated. Hereby polymers of the water up to the decamer, H₃O⁺ · (H₂O)₉, were found. The temperature dependence of the association equilibrium was measured and from this an approximate value for the association energy was derived. (auth)

18001 (ANL-6335) A STUDY OF THE EMANATION METHOD FOR THE DETERMINATION OF THE SURFACE AREA OF THORIUM OXIDE. S. B. Skladzien (Argonne National Lab., Ill.). Apr. 1961. Contract W-31-109-eng-38. 31p.

The surface areas of several thorium oxide and thorium oxide-uranium oxide preparations were measured by the emanation method. The radioactive gas-counting system employed is described, and a discussion of the procedure for converting counting data to terms of emanating power and finally to surface area values is given. Surface area values by the emanation method were compared with BET values from like samples. The difference between values obtained by the two methods was attributed to the efficiency of the radioactive gas-detecting system and the porosity of the oxide samples. The contribution of Rn²²² from the oxide samples containing uranium was found to be negligible and presented no problem. Samples fired at temperatures above 1500°C for one hour in air exhibited a marked increase in "room temperature" emanation rates. The predicted lattice-loosening temperature of metal oxides is approximately one-half their absolute melting point. Above this temperature, sufficient thermal agitation is induced to permit exchange and possibly permanent displacement of atoms in the crystal lattice. Therefore, firing these oxide preparations at temperatures above 1500°C would probably result in lattice defects throughout the crystal structure, with the surface defects contributing to an increase in surface area and a corresponding increase in the emanation rate. (auth)

18002 (DEG-Report-317) THE PAPER CHROMATOGRAPHIC SEPARATION AND ASSAY OF ⁹⁰Sr and ⁹⁰Y. P. M. Naylor (United Kingdom Atomic Energy Authority. Development and Engineering Group, Windscale, Cumb, England). Dec. 2, 1960. 7p.

Sr⁹⁰/Y⁹⁰ in secular equilibrium were separated by paper chromatography to provide standard amounts of Sr⁹⁰ and Y⁹⁰. These standards were used to determine the efficiency of counting equipment with respect to both these radioisotopes. The growth of Y⁹⁰ into Sr⁹⁰ and the decay of Y⁹⁰ were observed as counts per minute (cpm). By regarding the respective increase and decrease in cpm as an increase and decrease in the efficiency of the counting equipment it was possible to produce plots of efficiency against time. The graphs obtained provide data which facilitate the assay of Sr⁹⁰ and Y⁹⁰ in the same sample by a count of the sample at two different times. (auth)

18003 (HW-65704) SAMPLING AND ANALYTICAL DATA ON Al-Pu ALLOY FOR PRTR START-UP TESTS. C. H. Bloomster (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). June 15, 1960. 9p.

Analytical data on the PRTR fuel elements and other fuel elements fabricated by similar processes were gathered and analyzed. The mean melt analysis of the Al-Pu alloy for the PRTR start-up tests was 1.81 ± 0.04 wt.% Pu. Within a single melt the average deviation of the analyses of rod samples from the melt mean analysis was 0.04 wt.% Pu, the standard deviation was 0.05 wt.% Pu. Based

on data from fuel elements fabricated for irradiation tests by similar processes, the average deviation of analysis within a rod was 0.07 wt.% Pu in a 3 wt.% Pu alloy and 0.02 wt.% Pu in a 0.5 wt.% alloy, the standard deviations were 0.08 and 0.03 wt.% Pu, respectively. (auth)

18004 (PG-Report-41) THE DETERMINATION OF THORIUM IN URANYL NITRATE SOLUTIONS. T. J. Hayes (United Kingdom Atomic Energy Authority. Production Group. Chemical Services Dept., Springfields, Lancs, England). 1961. 13p.

A study of the Thorin complex with thorium was made and evidence is given for the formation of three complexes. An estimate is given for the stability constants of two of these complexes. A double coprecipitation on lanthanum fluoride was used to separate uranium prior to use of the spectrophotometric method for thorium, and fluoride is removed by acid evaporation and complexing with excess AlCl_3 . The final method is satisfactory for routine plant analyses. (D.L.C.)

18005 (SCTM-87-61(25)) DUST MONITORING BY THE DRY SLIDE SETTLING TECHNIQUE. W. J. Whitfield and R. C. Marsh (Sandia Corp., Albuquerque, N. Mex.). Mar. 1961. 16p.

A method of air sampling is described to evaluate the size, quantity and nature of airborne particulate matter in such environments as are found in white rooms, laboratories, and production areas. This method utilizes the particle settling principle for particle collection. Particle examination is facilitated by the use of a comparator type microscope which greatly simplifies particle counting, sizing, and identification, and reduces operator fatigue as compared to conventional microscopes. (auth)

18006 (WAPD-T-1348) THE SPECTROCHEMICAL ANALYSIS OF THE REACTIVE METALS, ZIRCONIUM, HAFNIUM, AND URANIUM. R. M. Jacobs (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Mar. 1961. Contract AT(11-1)-GEN-14. 23p.

Presented at a local meeting of the Spectroscopy Society of Pittsburgh on May 17, 1961.

Methods of analysis for Zr, U, and Hf are described. It is noted that except for precautions against toxic and radioactive hazards, standard laboratory procedures are adequate. However changing technology dictates a dynamic quality control program. (J.R.D.)

18007 (Y-1348) THE DETERMINATION OF URANIUM IN THE PRESENCE OF YTTRIUM BY MONOCHROMATIC X-RAY ABSORPTION. Thomas H. Barton, Jr. (Union Carbide Nuclear Co. Y-12 Plant, Oak Ridge, Tenn.). Mar. 1, 1961. Contract W-7405-eng-26. 10p.

A method for the determination of uranium in the presence of yttrium is described. The method consists of a monochromatic x ray absorption analysis for uranium at the uranium L_{II} absorption edge. No separation of the uranium and yttrium is necessary. The limit of error for a single determination at a 95% confidence level is 1.2% in the 10,000 ppm concentration range. (auth)

18008 (Y-1351) THE DETERMINATION OF URANIUM IN DIBUTYL CARBITOL BY MONOCHROMATIC X-RAY ABSORPTION. Thomas H. Barton, Jr., and Carl M. Neff (Union Carbide Nuclear Co. Y-12 Plant, Oak Ridge, Tenn.). Mar. 1, 1961. Contract W-7405-eng-26. 13p.

A monochromatic x-ray absorption method for the determination of uranium in dibutyl carbitol is described. Samples containing 0.001 to 0.015 gram of uranium per milliliter may be analyzed directly, while higher concentrations may be analyzed by dilution with pure carbitol. The limit

of error for a single determination at a 95% confidence level is ± 1.24 percent in the 0.005 to 0.015 g U/ml concentration range. (auth)

18009 OPTIMUM "COOLING TIME" TO MINIMIZE INTERFERING ACTIVITY IN NON-DESTRUCTIVE ACTIVATION ANALYSIS. Minoru Okada (Government Chemical Industrial Research Inst., Tokyo). Anal. Chim. Acta, 24: 410-12(May 1961).

In order to choose the best "cooling time" to minimize interfering γ rays in activation analysis, the "cooling time" is examined theoretically. There is an optimum cooling time which depends on the time of irradiation and on the half life of the nuclide to be determined. (auth)

18010 QUANTITATIVE CHROMATOGRAPHIC ANALYSIS USING RECTIFIED RADIO-FREQUENCY METHODS. I. LITHIUM, SODIUM AND POTASSIUM. J. A. Broomhead and N. A. Gibson (Univ. of Sydney). Anal. Chim. Acta, 24: 446-50(May 1961).

The Blake Zone Detector is shown to be a very useful apparatus for the location of ion zones separated by paper chromatography. In the case of the alkali metals, these zones can be estimated by measuring the impedance of their aqueous extract. An alternative method, that of measuring the area under the detector curve, does not provide a practical means of quantitative measurement. A new developing solvent is described for the paper chromatographic separation of lithium, sodium, and potassium chlorides. (auth)

18011 THIONIN DERIVATIVES IN THE EXTRACTION AND DIRECT PHOTOMETRIC DETERMINATION OF BORON. László Pásztor and J. Daniel Bode (Jones and Laughlin Steel Corp., Pittsburgh). Anal. Chim. Acta, 24: 467-73(May 1961).

Thionin and nine commercially available thionin derivatives were studied for their applicability in the analytical solvent extraction and direct photometric determination of boron. Azure A, Azure B, Azure C, Methylene Blue, New Methylene Blue N, Methylene Green, Toluidine Blue O, Thionin, and the eosinates of Azure A and B were investigated. Over thirty organic solvents, mostly chlorinated or brominated were tried with these dyes. 1,2-Dichloroethane, 1,2-dichloropropane, dichloromethane, 1,1,2-trichloroethane, *cis*-dichloroethylene, *o*-dichlorobenzene, 1,4-dichlorobutane, and mixtures of these solvents proved applicable. Many good dye-solvent combinations were found which were very attractive for the separation and determination of various amounts of boron. Only thionin itself proved unsatisfactory. (auth)

18012 THE USE OF MICROCHEMICAL METHODS IN RADIOCHEMICAL ANALYSIS. R. G. Monk and J. Herrington (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Anal. Chim. Acta, 24: 481-92(May 1961).

Techniques used for the radiochemical analysis of mixtures of active nuclides using 0.5- to 1-mg quantities of carrier are described and their advantages are discussed. Micromethods are listed for chemical yield determinations by spectrophotometry and microtitration, and details are given for the microtitration of a number of elements with EDTA, using a spectrophotometric end-point. A special fitment is described to enable the Unicam SP600 spectrophotometer to be used for microtitrations. Some values are given for the coefficients of variation obtained in typical chemical yield methods and in over-all radiochemical determinations of Mo^{99} , Ag^{111} , Cd^{115} , and Ba^{140} . (auth)

18013 SEPARATION OF NIOBIUM AND TANTALUM BY N-BENZOYL-N-PHENYLHYDROXYLAMINE. A. K. Majumdar and Bijoli K. Pal (Jadavpur Univ., Calcutta). *Anal. Chim. Acta*, 24: 497-8 (May 1961).

The pH range 3.5 to 6.5 for the complete precipitation of niobium and a pH below 1.5 for the precipitation of tantalum in separation and gravimetric analysis using N-benzoyl-N-phenylhydroxylamine are examined. They are verified to be correct. There is no possibility of the precipitation of hydrous oxide, even when the niobium or the tantalum solution is made ammoniacal in these pH ranges. (N.W.R.)

18014 THE SPECTROGRAPHIC DETERMINATION OF URANIUM-235. PART II. USING A DIRECT-READING ATTACHMENT AND A HOLLOW CATHODE SOURCE. Ted Lee and Lewis H. Rogers (Oak Ridge Gaseous Diffusion Plant, Tenn.). *Appl. Spectroscopy*, 15: 3-6 (1961).

The development of a direct-reading scanning technique, using a spectrograph with a hollow cathode discharge tube to excite the uranium samples, is described. For a determination consisting of ten scans on a single cathode containing the unknown, and ten scans on a single cathode containing a comparison standard, the precision obtained was from ± 1.2 to 1.8% of the amount present over a concentration range of 8 to 12% U^{235} . All precisions are expressed at the 95% confidence level. (auth)

18015 SPECTROGRAPHIC ANALYSIS OF HAFNIUM BY A POINT-TO-PLANE TECHNIQUE. R. C. Brayer, R. F. O'Connell, A. S. Powell, and R. H. Gale (Combustion Engineering, Inc., Windsor, Conn.). *Appl. Spectroscopy*, 15: 10-12 (1961).

A method is developed for the analysis of hafnium metal for aluminum, copper, iron, titanium, and tungsten in the ppm range and zirconium in the 1.0 to 4.0% range. Solid machined pieces 1×1 in. or larger are used. Spectra are excited with a low voltage ignited a-c arc with low inductance and capacitance. Hafnium serves as the internal standard. The method offers an increase in speed and improved precision over the carrier distillation technique which is commonly used. (auth)

18016 A SPARK SPECTROGRAPHIC PROCEDURE FOR THE DETERMINATION OF BORON IN SHEET STEEL. E. F. Runge and F. R. Bryan (Ford Motor Co., Scientific Lab., Dearborn, Mich.). *Appl. Spectroscopy*, 15: 13-15 (1961).

Sheet metal is directly analyzed for boron by means of spark excitation. Source inductance of 200 to 300 μ h, together with rotation of the specimen during excitation, provides detectability an order of magnitude better than conventional spark excitation of steel. Sheet material of 0.050 in. thickness and containing a nominal 0.004% boron is analyzed with a coefficient of variation of 3.2%. (auth)

18017 SPECTROPHOTOMETRIC DETERMINATION OF ALUMINUM IN URANIUM METAL AND ITS COMPOUNDS. Allan W. Ashbrook and G. M. Ritcey (Eldorado Mining and Refining Ltd., Ottawa). *Can. J. Chem.*, 39: 1109-12 (May 1961).

A rapid spectrophotometric method for the determination of small amounts of aluminum in uranium metal and uranium compounds is described. The method makes use of the yellow complex formed between aluminum and 8-hydroxyquinoline (oxine) at pH 9.5 to 10; the complex is extracted with carbon tetrachloride. Elements which interfere are extracted with 8-hydroxyquinoline. The method is suitable for the determination of up to 0.1% aluminum. (auth)

18018 DETERMINATION OF THE INDIVIDUAL RARE EARTH ELEMENTS IN THE RARE EARTH MINERALS BY NEUTRON ACTIVATION METHOD. II. DETERMINATION OF THE INDIVIDUAL RARE EARTH ELEMENTS IN GADOLINITE, XENOTIME, FERGUSONITE, EUXENITE AND YTTRIALITE. Isao Fujii (Tokyo Shibaura Electric Co.). *J. Atomic Energy Soc. Japan*, 3: 186-92 (Mar. 1961). (In Japanese)

A method is given for the quantitative separation and determination of individual rare earth elements in minerals. The method utilizes ion-exchange chromatography (0.5 M ammonium lactate in pH = 3.50, 4.30, 87°C) and pile-neutron (10^{11} n/cm²/sec) activation. The rare earths are extracted by the 5,7-dichloro-8-quinolinol method from each fraction and determined photometrically by the Neothorin method after destroying the organic reagent. Analyses of gadolinite, xenotime, fergusonite, euxenite, and yttrilite were carried out with precision. (auth)

18019 ANALYTICAL METHODS FOR In-As-Se ALLOYS. G. A. Kalyuzhnaya and A. S. Khalonii (Leningrad State Univ. and Leningrad Inst. of Physics and Technology). *Zavodskaya Lab.*, 27: 261-3 (1961). (In Russian)

An analytical scheme is developed for In-As-Se. Se is determined by weighing after sulfuric acid reduction, As is determined as bromate, and In is determined by trilonometric separation. The order of error is $\sim 1.5\%$; the time required is 1 hour. (R.V.J.)

18020 SPECTRAL ANALYSIS OF TUNGSTEN ADMIXTURES. V. S. Moleva and Sh. I. Peizulaev. *Zavodskaya Lab.*, 27: 309-10 (1961). (In Russian)

A method for the analysis of W that permits the determination of 15 different impurities with one spectrogram is described. (R.V.J.)

18021 SPECTRAL METHOD OF Nb AND Zr DETERMINATION IN ORES, CONCENTRATES, AND TAILS. P. D. Korzh and V. E. Pererva (Magnetogorsk Mining-Metallurgical Inst., USSR). *Zavodskaya Lab.*, 27: 311-13 (1961). (In Russian)

The spectral determination of Nb and Zr in ores, concentrates, and tails was carried out with standard apparatus. Constant graphs are plotted using a homological pair method. The mean square error is $\sim 6\%$. (R.V.J.)

General Inorganic and Physical Chemistry

18022 (ANL-6339) HIGH PURITY URANIUM COMPOUNDS. Final Report. H. J. Eding and E. M. Carr (Stanford Research Inst., Menlo Park, Calif.). Jan. 15, 1961. 39p. For Argonne National Lab. Contract W-31-109-eng-38, Subcontract 31-109-38-1030.

Uranium-aluminum compounds were prepared by solid-solid reaction of aluminum powder and uranium hydride; x-ray-diffraction patterns showed that single phases of UAl_2 , UAl_3 , and UAl_4 could be achieved. The uranium-beryllium compound, UBe_{13} , was prepared by solid-solid reaction of beryllium powder and uranium hydride. The uranium-boron compounds, UB_2 , UB_4 , and UB_{12} were prepared by solid reaction, and single borides were obtained; carbon contamination was especially serious in these samples. The uranium-carbon compounds, UC and UC_2 , were prepared by solid-solid reactions to 1200°C; the x-ray-diffraction patterns showed a mixture of phases, and higher temperatures are probably required. The uranium-nitrogen compounds, UN and UN_2 , were prepared by reaction of uranium with

ammonia at 850°C for UN₂ and subsequent heating of that product in vacuum for UN. The uranium-selenium compounds, USe and USe₂, were prepared in very small samples; the violence of the reaction of selenium with uranium hydride and the lack of availability of hydrogen selenide limits the size of preparations. The uranium-silicon samples, USi₂ and USi₃, were prepared by solid-solid reaction of UH₃ and Si; numerous attempts were made to prepare USi. One of the USi₂ samples was α -USi₂ and the other was β -USi₂. The uranium-sulfur compounds, US and US₂, were prepared; US₂ was prepared by forming uranium hydride in a flow furnace and then reacting the hydride with hydrogen sulfide; US was prepared by reacting some of the US₂ with UH₃. (auth)

18023 (HW-26676(Del.)) PRODUCTION TEST 235-5 PLANT PROCESS EVALUATION REDUCTION OF PLUTONIUM TETRAFLUORIDE WITH CALCIUM AND SULFUR. W. B. Kerr (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Feb. 10, 1953. Decl. with deletions Mar. 8, 1960. Contract W-31-109-Eng-52. 9p.

Reduction yields using calcium and sulfur in RM and RG line equipment were 87.3 and 96.8%, respectively. Long time reduction yields averaged 97.5% in RG equipment using calcium and iodine. The reductions were apparently complete, as indicated by some yields of 97.5 to 98.5%. In most cases of low yield, failure of the metal to agglomerate was shown by masses of metal in the slag. Additional difficulties were presented by the apparent wetting of the slag by metallic plutonium. (auth)

18024 (HW-41401(Del.)) CERIUM AND PLUTONIUM DIOXIDE—NOTES ON REDUCTION TO MASSIVE METAL. W. B. Tolley (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Feb. 13, 1956. Decl. with deletions Mar. 11, 1960. 8p.

In reduction reactions of CeO₂, with calcium and a CaCl₂ flux, the use of vibrational energy was shown to have a marked effect on the yield of coalesced metal. Buttons of 40 to 50% theoretical yield were obtained from the vibrated reductions. As the flux concentration is decreased, the slag becomes more viscous containing undissolved CaO. The undissolved CaO present prevents the metal from completely coalescing, but the metal can be recovered from the slag and coalesced under CaCl₂ containing a small amount of calcium to reduce any oxide skin present. Cerium pellet yields of 50 to 60% metal were obtained by the procedure and were not difficult to handle in air. Cerium was used as a stand-in material for plutonium. (B.O.G.)

18025 (NP-10049) PREPARATION OF HEAT AND RADIATION RESISTANT CHEMICALS FOR DIENE RUBBERS. Final Report. F. R. Hansen (Ferro Chemical Corp. Div. of Ferro Corp., Bedford, Ohio). Oct. 1960. Contract DA-11-070-508-ORD-889. 41p.

Procedures are presented for the preparation of ~50 compounds which were evaluated as inhibitors against the deteriorating effects of heat aging on diene vulcanizates. The majority of the compounds were closely related to the fatty-acid soap combinations with pentaerythritol. None of the synthesized chemicals showed improvement over the latter combination when they were evaluated in diene vulcanizates. (auth)

18026 (TID-12451) SOLUBILITY OF IRON SULFIDES. Technical Report No. 61C. Herbert A. Pohl (Du Pont de Nemours (E.I.) & Co., Atomic Energy Div., Wilmington, Del. and Princeton Univ., N. J. Plastics Lab.). Apr. 1, 1961. Contract DA-36-039sc-78105. 54p.

The thermodynamic data relating to the solubility of

various iron sulfides were collated and extended to elevated temperatures (0 to 230°C). The effects of added H₂S, acid, or base are included. It is found that, other conditions remaining sensibly constant, the solubility of iron sulfides generally decreases with rising temperature. The data permit an explanation of the nature and causes of sulfide deposition in iron-bearing aqueous systems. In equipment made principally of ferrous metals in which water, H₂S, and small amounts of other materials are present under pressure at changing temperatures, massive transport of iron occurs. This causes depositions of iron sulfides which may interfere with process operation. In the presence of H₂S-saturated water and aqueous flow through temperature gradients, iron is transported and laid down as various sulfides. Near the underlying steel surfaces of equipment in such streams, at temperatures below 155°C, the deposition is principally troilite (approx FeS_{1.01}). Above this is formed, crystallizing more like pyrrhotite, a magnetic composition approx FeS_{1.01-1.2}. At higher temperatures above 155°C (FeS₂) marcasite and traces of pyrite (FeS₂) are formed. If precipitation is slow, the latter is laid down, if rapid, the former, less stable form of FeS₂ is laid down. Application of the findings to the dual temperature process for heavy water is described. (auth)

18027 (CEA-tr-R-1111) DÉTERMINATION DE LA VALENCE DU POLONIUM EN SOLUTION. (Determination of the Valence of Polonium in Solution). B. P. Nikolskii (B. J. Nikolsky), G. S. Sinitsyna (Sinitsina), and D. M. (N.) Ziv. Translated into French from Trudy Radiievo Inst. im. V. G. Khlopina, 8: 141-52(1958). 26p.

The possibility of applying the Nernst electrochemical equation to extremely dilute solutions of polonium (up to a concentration of 5×10^{-14} m/l) and with a constant ionic force of the solution was shown. It was established that the most stable valence is 4+. The valence of the reduced form in solution is 2+ and not 3+ as was previously thought. The normal electrode potential of the tetravalent polonium was determined to be $+0.765 \pm 0.005$ v. The normal potential of bivalent polonium was $+0.68 \pm 0.01$ v. (tr-auth)

18028 (CEA-tr-R-1134) EMPLOI DE L'ÉLECTROLYSE EN CHIMIE ET EN TECHNOLOGIE DES ÉLÉMENTS RARES. (Use of Electrolysis in the Chemistry and Technology of Rare Elements). S. I. Skliarenko. Translated into French from Khim. Prom., 3: 455-63(1958). 45p.

A bibliographic study is made of the use of electrolysis in the chemistry and technology of the rare elements. Electrolysis in fused and aqueous solutions for the obtention of rare elements and their alloys and amalgams are reported, 78 references. (J.S.R.)

18029 (CEA-tr-R-1166) INFLUENCE DE LA NATURE ET DE LA CONCENTRATION DE L'ACIDE SUR LA VALEUR DU POTENTIEL D'ELECTRODE DU POLONIUM. (Effects of the Nature and Concentration of Acid on the Value of the Electrode Potential of Polonium). B. P. Nikolskii (Nicol'skii), D. M. Ziv, B. I. Schestakov, and G. S. Sinitsyna (Sinitzin). Translated into French from Trudy Radiievo Inst. im. V. G. Khlopina, 8: 153-7(1958). 15p.

It is shown that the electrochemical potential of polonium deposits depends to a large extent on the nature and the concentration of the acid. In nitric acid solutions, when the concentration is increased from 0.001 to 1.5 N, an increase of the electrochemical potential is observed, evidently because of the appearance of polonium ions with very high valence values. In 3.0 N HNO₃ solution, a lowering of the potential occurs because of complex ion formation. In hydrochloric and acetic solutions when the concentration of the electrolyte increases above 0.1 N, a decrease of the

potential is observed, caused by complex formation. It was shown that the electrochemical potential does not depend on the pH of the solution between pH 1 and 6. The Nernst equation is applicable to diluted solutions of polonium. In 0.001 N HNO_3 solution the largest part of the polonium is in the tetravalent state. In 1.5 N HNO_3 solutions, polonium has a very high degree of oxidation (6+). (tr-auth)

18030 (CEA-tr-R-1207) SUR LA NATURE DE L'ÉCHANGE ISOTOPIQUE DE L'HYDROGENE DANS LES SOLUTIONS. (On the Nature of Isotopic Exchange of Hydrogen in Solutions). A. I. Shatenshtein. Translated into French from *Uspekhi Khim.*, 28: No. 1, 3-32(1959). 88p.

A bibliographic survey is made of recent studies on the nature of the isotopic exchange of hydrogen in solutions. The role of acidity or alkalinity on hydrogen exchange, fast and slow isotopic exchange, classification of exchange reactions in the solutions, isotopic exchange and acid-base interactions, and relations between the rapidity of hydrogen exchange, ionization velocity, and ionization magnitude are considered. 122 references. (J.S.R.)

18031 (NP-tr-597) PLATINUM ELECTRODES. I. THE CAPACITY OF PLATINISED PLATINUM IN VARIOUS ELECTROLYTES AND THE ELECTROMOTIVE BEHAVIOUR OF ADSORBED HYDROGEN. A. Slygin and A. Frumkin. Translated by F. Hudswell from *Acta Physicochim. U.R.S.S.*, 3: 791-818(1935). 40p.

The dependence of the potential difference, ϕ , between a solution and metal using a platinized platinum electrode, on the quantity of electricity, Q , supplied in the interval between the potential of the hydrogen electrode and an anodic polarization of ~ 1 volt in H_2SO_4 , HCl , KOH , HBr , Na_2SO_4 , NaCl , and NaBr , was investigated. It was found that the Q is mainly consumed in the desorption of adsorbed hydrogen (hydrogen region), after which follows a region of rapid potential change (double-layer region), and finally oxidation of the electrode. The effects of platinizing conditions on the shape of the ϕ - Q curves were studied. Investigations were made of the behavior of the electrode after interruption of the polarizing current, the reversibility of the ϕ - Q curves, and the effect of current density during polarization on the ϕ - Q curves. (auth)

18032 (NP-tr-598) PLATINUM ELECTRODES. II. THE ADSORPTIVE PROPERTIES OF THE PLATINUM ELECTRODE. A. Slygin, A. Frumkin, and W. Medvedovski. Translated by F. Hudswell from *Acta Physicochim. U.R.S.S.*, 4: 911-28(1936). 28p.

The dependence of the amounts of acid and alkali adsorbed on the potential of a platinized platinum electrode was determined in H_2SO_4 , HCl , and HBr , and in the mixtures Na_2SO_4 - H_2SO_4 , NaCl - HCl , NaBr - HBr , NaCl - NaOH , NaBr - NaOH , and NaBr - KOH . An interpretation of the shape of the adsorption curves is outlined. The change of the amounts of acid and alkali adsorbed with potential was compared with the quantity of electricity necessary to bring the electrode to potential. The change of the amount adsorbed with potential was observed during slow oxidation of a hydrogen-saturated electrode with molecular oxygen. The change of the amount adsorbed was determined, in H_2SO_4 and Na_2SO_4 , during the slow reduction of an oxidized electrode with molecular hydrogen. (auth)

18033 ON THE COMPLEX CHEMISTRY OF THE TERVALENT RARE-EARTH IONS. VI. A STUDY OF THE COMPLEX FORMATION BETWEEN GADOLINIUM AND GLYCOLATE IONS IN AN ANION EXCHANGER. Arthur Sonnesson (Univ. of Lund, Sweden). *Acta Chem. Scand.*, 15: 1-10(1961). (In English)

The complex formation between gadolinium and glycolate ions in an anion exchanger phase was studied at 20°C , a resin with quaternary ammonium groups (Dowex 1 \times 4) being used. The glycolate concentration of the resin was varied widely by exchange for perchlorate ions. The amount of water of the resin phase was determined and the ionic strength of the resin phase was calculated formally. The ionic strength of the water phase was approximately constant, 0.21 M . The glycolate concentration of the two phases was determined by oxidation with potassium permanganate in a solution made alkaline by sodium carbonate. It was found that the ligand number of the resin phase could not be calculated in the whole concentration range as the ionic strength probably varied too widely, owing to the dependence of the swelling upon the glycolate load on the exchanger. Approximate values of $K \cdot \beta_{nR}$, where K is a constant, were determined, but it was not possible to compute K . The values of $K \cdot \beta_{nR}$ ($n = 1, 2, 3, 4$) are of the same order of magnitude as the potentiometrically obtained complexity constants for a water solution. It seems probable that only the first anionic complex is formed in the resin phase. Complexity constants of the gadolinium-glycolate system are also reported for solutions with the ionic strengths 0.21 and 3.0 M . (auth)

18034 STUDIES ON THE HYDROLYSIS OF METAL IONS 32. THE URANYL ION, UO_2^{2+} , IN Na_2SO_4 MEDIUM. Alf Peterson (Royal Inst. of Tech., Stockholm). *Acta Chem. Scand.*, 15: 101-20(1961). (In English)

The hydrolysis of UO_2^{2+} was studied in a 1.5 M (sodium)-sulfate medium at 25°C by electrometric titration using glass electrodes. The total uranium concentration ranged between 0.0003 and 0.04 M . Special studies were made on similar cells without uranyl or with uranyl at acidities giving negligible hydrolysis. The results make it reasonable to assume $K(\text{HSO}_4^- \rightleftharpoons \text{H}^+ + \text{SO}_4^{2-}) \approx 0.4 M$ and to neglect $\text{Na}^+ - \text{SO}_4^{2-}$ complexing. $K(\text{Na}^+ + \text{SO}_4^{2-} \rightleftharpoons \text{NaSO}_4^-)$ is estimated to be $\approx 0.13 M^{-1}$. The average number of sulfate groups bound per uranyl group was found to lie between 2 and 3 with a probable value of about 2.9. The sulfate groups of the uranyl sulfate complexes seem to have somewhat lower affinity for protons than the free sulfate ions. The data indicate the formation of "core + links" complexes of the general formula $\text{UO}_2(\text{OH})_n\text{UO}_2^{2+}$. "Direct analysis" indicates that at least the first four complexes, $(\text{UO}_2)_2(\text{OH})_2^{2+}$, $(\text{UO}_2)_3(\text{OH})_4^{2+}$, $(\text{UO}_2)_4(\text{OH})_6^{2+}$, $(\text{UO}_2)_5(\text{OH})_8^{2+}$, exist. If only these are assumed to exist, the best values for the equilibrium constants k_n of the reaction, $(n+1)\text{UO}_2^{2+} + 2n\text{H}_2\text{O} \rightleftharpoons \text{UO}_2(\text{OH})_n\text{UO}_2^{2+} + 2n\text{H}^+$, are $\log k_1 = -8.17$, $\log k_2 = -16.20$, $\log k_3 = -24.51$, and $\log k_4 = -32.14$. The data were also well explained by theory "IIIc", assuming an infinite series of complexes with $\log k_n = -(7.66n + \log n! + 0.52)$, thus $\log k_1 = -8.18$, $\log k_2 = -16.15$, $\log k_3 = -24.29$ and $k_4 = -32.56$. (auth)

18035 THE CRYSTAL STRUCTURE OF THE LANTHANIDE OXYIODIDES, SmOI , TmOI AND YbOI . F. H. Kruse, L. B. Asprey, and Bruno Morosin (Los Alamos Scientific Lab., N. Mex.). *Acta Cryst.*, 14: 541-2(May 10, 1961). (In English)

A tabulation of the partial powder x-ray diffraction patterns of the lanthanide oxyiodides SmOI , TmOI , and YbOI is given. These oxyiodides crystallize in the tetragonal PbFCl structure type; the unit cell dimensions are presented. For TmOI the atomic position parameters and the interatomic distances are also tabulated. (N.W.R.)

18036 CELL DIMENSIONS AND SPACE GROUP OF BISMUTH(II) CHLORO-ALUMINATE. H. A. Levy, P. A.

Agron, M. D. Danford, and R. D. Ellison (Oak Ridge National Lab., Tenn.). *Acta Cryst.*, 14: 549-50 (May 10, 1961). (In English)

The cell dimensions and interplanar spacings of bismuth (I) chloroaluminate are determined from crystals grown from melt under helium. Single crystal diffraction patterns show the crystal to be rhombohedral. The hexagonal unit cell of BiAlCl_4 is $a = 11.855 \pm 0.003$ and $c = 29.991 \pm 0.009 \text{ \AA}$, corresponding to the rhombohedral cell $a = 12.109 \pm 0.002 \text{ \AA}$ and $\alpha = 58^\circ 29' \pm 2'$. Precession patterns of the hexagonal levels $h0l$, $h1l$, and $h2l$ show the systematic absences hhl (absent if $l \neq 2n$) and hkl (absent if $-h + k + l \neq 3n$). The space groups consistent with these absences are $R3c$ and $R3c$ with the probable space group being $R3c$. (N.W.R.)

18037 ON THE ABSORPTION SPECTRUM OF ICl . PART II. CHLORINE ISOTOPES IN IODINE CHLORIDE. E. Hulthén, N. Järlsäter, and L. Koffman. *Arkiv Fysik*, 18: 479-512 (1961). (In English)

In the absorption spectrum of ICl the transition $A^3\Pi_1 - X^1\Sigma^+$ was investigated at high resolution, resulting in detailed records of the $^3\Pi_1$ state in ICl^{35} and ICl^{37} . Some close relations are established between the perturbations in the vibrational states of $^3\Pi_1$ and the anomalous behavior of their recently discovered magnetic rotation. The terminal of the vibrational progression in $^3\Pi_1$ at its limit of dissociation exhibits a remarkable break which is accompanied by a new set of vibrational states, here named X-levels. The dissociation energy of ICl^{35} is determined with high precision. The present investigation gives extended term-tables of the $^3\Pi_1$ state. (auth)

18038 THE KINETICS OF PROTACTINIUM PRECIPITATED ON LEAD. O. Gautsch (Kernreaktor Bau- und Betriebs-GmbH, Karlsruhe, Ger.). *Atompraxis*, 7: 101-3 (Mar. 1961). (In German)

The kinetics of protactinium precipitated on lead was calculated on the basis of radioactive decomposition, and the precipitation rate was compared with the rate of decomposition. In addition, attempts were made to precipitate protactinium on manganese and manganese dioxide. (auth)

18039 THE THERMAL CONDUCTIVITY OF MOLTEN SALTS. I. A Transient Measurement Method. A. G. Turnbull (Commonwealth Scientific and Industrial Research Organization, Melbourne). *Australian J. Appl. Sci.*, 12: 30-41 (Mar. 1961).

Values of thermal conductivity and methods of measurement for molten salts at elevated temperatures are critically reviewed. A simple and accurate apparatus based on the transient heating of a thin wire in the melt is described and theory and possible errors discussed. Thermal conductivities are measured for the $\text{KNO}_3\text{-NaNO}_2\text{-NaNO}_3$ eutectic in the liquid and solid state and for five other useful eutectic melts. (auth)

18040 THE INTERACTION OF BORON TRIFLUORIDE WITH HYDRAZINE. W. G. Paterson and M. Onyszchuk (McGill Univ., Montreal). *Can. J. Chem.*, 39: 986-94 (May 1961).

Boron trifluoride and anhydrous hydrazine react rapidly at 25° *in vacuo* yielding at 1:1 complex compound, $\text{BF}_3 \cdot \text{N}_2\text{H}_4$ (m.p. 87°), while at higher temperatures, or with diethyl ether as solvent, they form complex mixtures containing 52.2 to 63.5 mole % BF_3 ; but in tetrahydrofuran solution the 2:1 adduct, $2\text{BF}_3 \cdot \text{N}_2\text{H}_4$ (m.p. 260°) is formed. The x-ray powder diffraction pattern of $\text{BF}_3 \cdot \text{N}_2\text{H}_4$ consists of 28 lines from which a unit cell with triclinic symmetry was calculated. The thermal decomposition of $\text{BF}_3 \cdot \text{N}_2\text{H}_4$ is

complex, yielding in part N_2 , NH_3 , NH_4BF_4 , and BN . Hydrolysis of $\text{BF}_3 \cdot \text{N}_2\text{H}_4$ yields a mixture of hydroxyfluoroborate ions. At -80° , $\text{BF}_3 \cdot \text{N}_2\text{H}_4$ absorbs NH_3 to form a diammoniate which liberates NH_3 slowly at higher temperatures. Partial displacement of BF_3 from $\text{BF}_3 \cdot \text{N}_2\text{H}_4$ by HCl and partial absorption of HCl by $\text{BF}_3 \cdot \text{N}_2\text{H}_4$ occur simultaneously at 110° . Infrared spectra of $\text{BF}_3 \cdot \text{N}_2\text{H}_4$ and $2\text{BF}_3 \cdot \text{N}_2\text{H}_4$ were measured in the range of 4000 to 650 cm^{-1} and frequency assignments were made. (auth)

18041 THE REVERSIBLE ELECTRODE POTENTIAL OF THE SYSTEM U/UCl_3 IN MOLTEN CHLORIDE SOLUTIONS. D. Inman and J. O'M. Bockris (Univ. of Pennsylvania, Philadelphia). *Can. J. Chem.*, 39: 1161-3 (May 1961).

An $E_{\text{UCl}_3}^0 - E_{\text{AgCl}}^0 = 1.638 \text{ v}$ is obtained at 453°C in a helium atmosphere from a line of theoretical slope $n = 3$. The f_{UCl_3} values are 0.38 and 0.08 respectively. The various concentrations of UCl_3 in LiCl-KCl were prepared by anodic dissolution of uranium wires in several glass diaphragm compartments similar to that used for the reference electrode. Both compartments and the reference electrode were immersed in a bath of purified LiCl-KCl eutectic. The UCl_3 concentrations were determined by the dichromate method. A standard sample containing 1.025 mg of uranium was determined as 0.998 mg by this method. The anodic dissolution process is approximately 100% efficient on the basis of $n = 3$. The electromotive force of the cell $\text{U}^-/\text{UCl}_3, \text{LiCl-KCl:AgCl}, \text{LiCl-KCl/Ag}^+$ at 453°C is tabularly presented. (N.W.R.)

18042 STUDIES IN LITHIUM OXIDE SYSTEMS: X, LITHIUM PHOSPHATE COMPOUNDS. T. Y. Tien and F. A. Hummel (Pennsylvania State Univ., University Park). *J. Am. Ceram. Soc.*, 44: 206-8 (May 1961).

As a preliminary to the investigation of the ternary systems $\text{Li}_2\text{O-B}_2\text{O}_3\text{-P}_2\text{O}_5$ and $\text{Li}_2\text{O-SiO}_2\text{-P}_2\text{O}_5$, the existence of the previously reported lithium ortho-, pyro-, and metaphosphate compounds was confirmed. A rapid, reversible inversion takes place in $\text{Li}_4\text{P}_2\text{O}_7$ at 630°C . New data on the melting points, optical properties, and x-ray diffraction patterns of each of the compounds were obtained. (auth)

18043 INTERSTITIAL COMPOUNDS OF BORON. V. I. Matkovich (Allis-Chalmers Mfg. Co., Milwaukee). *J. Am. Chem. Soc.*, 83: 1804-6 (Apr. 20, 1961).

A model of the structure of boron compounds is presented which explains such compounds as B_{13}O_2 , B_4C , B_{13}C_2 , B_{13}P_2 , B_{13}As_2 , and B_4Si as a group of interstitial compounds of boron. Formation of a new boron sulfide, B_{13}S , belonging to the same group is reported. (auth)

18044 THE TEMPERATURE DEPENDENCE OF THE SOLVENT ISOTOPE EFFECT. R. L. Heppollette and R. E. Robertson (National Research Council of Canada, Ottawa). *J. Am. Chem. Soc.*, 83: 1834-8 (Apr. 20, 1961).

Rate data for the hydrolysis of isopropyl bromide in deuterium oxide are determined over a temperature of 35 to 80° . By comparison with earlier data for hydrolysis in water, it was shown that the solvent isotope effect ($k_{\text{D}_2\text{O}}/k_{\text{H}_2\text{O}}$) decreased with increasing temperature more rapidly than the solvent isotope effect for relaxation processes in bulk solvent. While this conclusion may be general for the hydrolysis of halides, it will not hold for the sulfonates where very much smaller values of $d(k_{\text{D}_2\text{O}}/k_{\text{H}_2\text{O}})/dT$ are found. The sources of the solvent isotope effect for hydrolysis are examined. The results are shown to be consistent with the hypothesis that the major contribution to the observed characteristic differences resides in the relative structural stability of the initial state solvation shells. (auth)

18045 SECONDARY α -DEUTERIUM ISOTOPE EFFECT. THE MECHANISM OF THE CIS-TRANS CATALYZED ISOMERIZATION OF MALEIC ACID. Stanley Seltzer (Brookhaven National Lab., Upton, N. Y.). *J. Am. Chem. Soc.*, 83: 1861-5 (Apr. 20, 1961).

The secondary α -deuterium isotope effect in the potassium thiocyanate-catalyzed isomerization of maleic acid-2,3- d_2 was measured over the temperature range 15 to 80°. From the data the net change in the carbon-hydrogen vibrational frequencies in going from the ground state to the transition state are evaluated, and it appears as if the transition state lies a little more than half way along the path between a trigonal and tetrahedral carbon atom. The infrared spectrum of maleic anhydride- d_2 is measured and compared with that for maleic anhydride. (auth)

18046 INDUCED OXYGEN EXCHANGE BETWEEN HYDROGEN PEROXIDE AND WATER. M. Anbar (Weizmann Inst. of Science, Rehovoth, Israel). *J. Am. Chem. Soc.*, 83: 2031-5 (May 5, 1961).

An induced isotopic exchange of oxygen between H_2O_2 and water was observed on interaction of H_2O_2 with OCI^- , IO_4^- , MnO_4^- , Fe^{2+} , Fe^{3+} , and Ce^{4+} as well as with NO_2 and NO_2^- . No induced isotopic exchange between different H_2O_2 molecules was detected. The formation of peroxy-complexes of the type $XOOH$ is suggested which facilitates the isotopic exchange with water: $XOH + HOOH \rightleftharpoons XOOH + H_2O$; $XOOH + H_2O^* \rightleftharpoons HO\dot{O}H + XOH$. (auth)

18047 THE EXCHANGE OF OXYGEN BETWEEN HYDROGEN PEROXIDE AND WATER IN NITRIC ACID SOLUTIONS. M. Anbar and S. Guttman (Weizmann Inst. of Science, Rehovoth, Israel). *J. Am. Chem. Soc.*, 83: 2035-7 (May 5, 1961).

The kinetics of isotopic exchange of H_2O_2 with water in nitric acid solutions were studied at 60 and at 100°. The dependence of the rate of exchange on the concentrations of nitric acid, nitrate ions, and perchloric acid suggests nitrogen pentoxide as nitrating agent. A simultaneous isotopic exchange between hydrogen peroxide and nitric acid is observed; on the other hand, no exchange between water and nitric acid is induced by the hydrogen peroxide exchange. The mechanism of exchange postulates pernitric acid as intermediate: $N_2O_5 + H_2O_2^{**} \rightarrow HNO_3 + O_2NO\dot{O}H$; $O_2NO\dot{O}H + H_2O \rightleftharpoons O_2NOH + HO\dot{O}H$. (auth)

18048 ELECTROPHILIC DISPLACEMENT REACTIONS. XI. SOLVENT ISOTOPE EFFECTS IN THE PROTODEBORONATION OF ARENEBORONIC ACIDS. Henry G. Kuivila and K. V. Nahabedian (Univ. of New Hampshire, Durham). *J. Am. Chem. Soc.*, 83: 2164-6 (May 5, 1961).

The effect of solvent hydrogen isotope composition (hydrogen and deuterium) on the rates of protodeboronation of *p*-methoxybenzeneboronic acid in 6.3 *M* sulfuric acid and of 2,6-dimethoxybenzeneboronic acid in 0.1 *M* perchloric acid were studied. In the former case k_H/k_D is 3.7 and the rate constant variation with solvent isotope composition is nearly linear. In the latter case k_H/k_D is 1.7 and variation of rate constant with solvent isotope composition is non-linear. This rate behavior is in quantitative accord with that expected for a rate-determining proton transfer. (auth)

18049 FIRST OBSERVATION OF AQUEOUS TETRAVALENT AMERICIUM. L. B. Asprey and R. A. Penneman (Los Alamos Scientific Lab., N. Mex.). *J. Am. Chem. Soc.*, 83: 2200 (May 5, 1961).

A solution of pure Am^{4+} was prepared in saturated NH_4F . Black $Am(OH)_4$ was freshly prepared by heating $Am(OH)_3$

with 0.2 *M* $NaOCl$ –0.2 *M* $NaOH$. It was treated with saturated aqueous NH_4F . The slurry of $Am(OH)_4$ completely dissolves in 15 *M* NH_4F to give an americium concentration of 0.01 *M*. The resulting clear (pink-red) solution shows absorption peaks of Am^{4+} . The peak at 4560 Å ($\epsilon = 25$) is sharp and well separated. Heating the solution in 15 *M* NH_4F to 90°C does not cause disproportionment of Am^{4+} or its chemical reduction by water. Oxidation and reduction tests are also discussed. (N.W.R.)

18050 A HIGHER HYDRIDE OF YTTERBIUM. James C. Warf and Kenneth Hardcastle (Univ. of Southern California, Los Angeles). *J. Am. Chem. Soc.*, 83: 2206-7 (May 5, 1961).

The preparation of ytterbium and europium hydrides and the properties of each are discussed. It is shown that $YbH_{2.55}$ may be produced by subjecting 99.8% ytterbium metal in an atomic hydrogen welded, double-walled bomb to heat and pressure. The metal is first heated in vacuo and then allowed to absorb hydrogen at atmospheric pressure until the composition is $YbH_{1.90}$. The hydrogen pressure in the apparatus is increased to several atmospheres. At a composition of $YbH_{2.4}$ the dissociation pressure is 20.9 atm at 312°C. Examination by powder x-ray-diffraction techniques shows the presence of a fcc phase along with a small amount of the orthorhombic dihydride. The lattice constants are 5.192 ± 0.002 Å. The same test was applied to europium but a hydride as high as that in ytterbium was not obtained. The orthorhombic $Eu_{1.8-1.9}$ is formed. (N.W.R.)

18051 THE VAPOR PRESSURES OF SOME HEAVY TRANSITION-METAL HEXAFLUORIDES. George H. Cady and George B. Hargreaves (Univ. of Washington, Seattle). *J. Chem. Soc.*, 1563-8 (Apr. 1961).

The vapor pressures of the hexafluorides of tungsten, molybdenum, rhenium, osmium, and iridium were measured by a static method using a diaphragm gauge of high sensitivity. Hitherto unknown solid-solid transitions are reported for rhenium, osmium, and iridium hexafluorides together with those known for tungsten and molybdenum hexafluorides. These are, respectively: -1.9° , -0.4° , $+0.4^\circ$, -8.2° , and -8.7° . From the vapor-pressure data more accurate physical constants, latent heats of vaporization and sublimation, heats of fusion and transition, and entropies of fusion, transition, and vaporization were calculated. Nuclear magnetic resonance studies with both solid and liquid hexafluorides suggest that there is molecular rotation in the solid state above the transition point. (auth)

18052 VAPOR PRESSURES OF SOME FLUORIDES AND OXYFLUORIDES OF MOLYBDENUM, TUNGSTEN, RHENIUM, AND OSMIUM. George H. Cady and George B. Hargreaves (Univ. of Washington, Seattle). *J. Chem. Soc.*, 1568-74 (Apr. 1961).

The vapor pressures of the pentafluorides, ReF_5 , MoF_5 , OsF_5 , the oxytetrafluorides, $ReOF_4$, $MoOF_4$, WOF_4 , and the oxyfluorides $ReOF_3$ and ReO_2F_3 were measured by a static method using a diaphragm gauge of high sensitivity. The physical constants, heats of sublimation and vaporization, and entropies of vaporization were derived from the vapor-pressure data. The oxytetrafluoride, $ReOF_4$, was studied in detail and a hitherto unknown solid–solid transition at 30.0° is reported. The thermal disproportionation of the pentafluorides is described. (auth)

18053 SOME ACETAMIDE COMPLEXES OF THE ACTINIDE TETRACHLORIDES. PART I. URANIUM, NEPTUNIUM, AND PLUTONIUM. K. W. Bagnall, A. M. Deane, T. L. Markin, P. S. Robinson, and M. A. A. Stewart

(United Kingdom Atomic Energy Authority. Research Group, Harwell, Berks, Eng.). *J. Chem. Soc.*, 1611-17 (Apr. 1961). (AERE-R-3434)

Ionic compounds of composition $MCl_4 \cdot 6Ac \cdot NH_2$ ($M = U$, Np , or Pu) were prepared in which the acetamide molecule is co-ordinated to the M^{4+} ion through the carbonyl-oxygen atom. Similar, but more stable, complexes with NN -dimethylacetamide, $MCl_4 \cdot 2.5Ac \cdot NMe_2$, were also prepared; these are presumably dimeric. (auth)

18054 THE NITROUS ACID-TRIBUTYL PHOSPHATE COMPLEX. J. M. Fletcher, D. Scargill, and J. L. Woodhead (United Kingdom Atomic Energy Authority, Research Group, Harwell, Berks, Eng.). *J. Chem. Soc.*, 1705-7 (Apr. 1961).

Tributyl phosphate extracts nitrous acid almost quantitatively from aqueous solutions. The spectrum, from 320 to 400 μ , shows the enhanced fine structure characteristic of molecular nitrous acid and of alkyl nitrites. Distribution data indicate a 1:1 complex, $[Bu_3PO_4 \cdot HO \cdot NO]$, and infrared spectra that the hydrogen-bonding to the phosphoryl-oxygen atom modifies the bonding in nitrous acid toward an ionic structure. (auth)

18055 CHEMICAL AND MAGNETIC PROPERTIES OF LANTHANUM DICARBIDE AND SESQUICARBIDE. N. N. Greenwood and A. J. Osborn (The University, Nottingham, Eng.). *J. Chem. Soc.*, 1775-82 (Apr. 1961).

Lanthanum dicarbide and sesquicarbide are prepared by heating lanthanum dihydride with the stoichiometric amounts of graphite. The dicarbide is diamagnetic and the sesquicarbide very slightly paramagnetic, indicating almost complete delocalization of the extra valency electrons in a conduction band. Reactions of the carbides with a variety of reagents are studied and compared with the corresponding reactions of calcium carbide, the gaseous products being identified and quantitatively determined by infrared spectroscopy and gas-liquid chromatography. (auth)

18056 ACTIVATED NATURAL CRYSTALS. Giovanna Mayr (Università, Milan). *Nature*, 190: 229-31 (Apr. 15, 1961).

When Ca^{45} , C^{14} , P^{32} , or S^{35} radiation sources were applied to slices of apatite, calcite, celestine, gypsum, or pyrite for times ranging from a few days to several weeks the active substance was found in the crystals. Results could not be explained on the basis of ordinary diffusion. It was concluded that not only the active atoms migrate, but also atoms and ions have undergone collision; this may occur from source to contacting substance as well as vice versa. (C.H.)

18057 THE BURNING OF METALS. P. L. Harrison and A. D. Yoffe (Cavendish Lab., Cambridge, Eng.). *Proc. Roy. Soc. (London)*, A, 261: 357-70 (May 16, 1961).

A study is made of the mechanism by which metals burn. Experiments are carried out with wires of aluminum, iron, magnesium, molybdenum, titanium and zirconium in oxygen and oxygen + nitrogen mixtures. The rate of propagation of the combustion zone along the wire is dependent upon the oxygen pressure in the atmosphere, suggesting that combustion is largely controlled by gaseous diffusion through the atmosphere. Some of the factors influencing the mode of burning and the reaction rates are studied, and the temperatures attained under the given experimental conditions are measured. The mode of burning is determined by the relative melting and boiling points of the metal and its oxide. Metals with low boiling points, such as aluminum and magnesium, burn in the vapor phase. Metals that have high boiling points, but that melt readily, burn at the sur-

face of a molten oxide + metal mixture, provided the oxide also melts readily but has a high boiling point. Iron and titanium are examples of such metals. If, as with zirconium, the metal has a high boiling point and possesses a refractory oxide, a solid oxide film, which slows the reaction, can be formed on the metal surface. Metals such as molybdenum, which form oxides that readily sublime, burn at the surface of the metal. Color temperatures attained during the burning of iron, titanium, and zirconium in oxygen are found to be higher for greater pressures of oxygen. The temperature varies from 2600 to 3800°K, and is highest for the metal with the greatest heat of oxidation, when measured per gram of oxygen consumed. The burning of a metal sphere to a molten oxide + metal mixture in a convection-free monomolecular gas is treated theoretically. The variation of combustion temperature with oxygen pressure predicted by the theory agrees satisfactorily with that obtained experimentally. (auth)

18058 EFFECTS OF MELT COMPLEXING ON THE CRYSTALLIZATION COEFFICIENT IN $PbCl_2$ - $ThXCl_2$ - KCl AND $CaCl_2$ - $CdCl_2$ - KCl . V. R. Klokman, K. G. Myakishev, and V. S. Smirnov. *Radiokhimiya*, 2: 175-82 (1960). (In Russian)

Crystallization coefficients for $RaCl_2$ ($ThXCl_2$) in $PbCl_2$ - KCl and $CdCl_2$ in $CaCl_2$ - KCl systems at various temperatures were determined in order to evaluate the dependence on macrocomponent content in the melt. The study of $RaCl_2$ and $CdCl_2$ distribution between $PbCl_2$ and $CaCl_2$ crystals, respectively, indicates that microcomponent complexing results in an increased coefficient of crystallization. (R.V.J.)

18059 ON NON-CONTINUOUS CHANGES OF CHEMICAL PROPERTIES OF PENTAVALENT ACTINIDE OXIDE IONS WITH INCREASING ELEMENT INDEX NUMBER. Yu. A. Zolotov. *Radiokhimiya*, 2: 192-6 (1960). (In Russian)

Correlations of the behavior of UO_2^{+} - AmO_2^{+} ion series indicated variable changes in certain properties with the increase of the element index number. A certain similarity was observed between pentavalent uranium and plutonium ions on one side and pentavalent neptunium and americium on the other side. (R.V.J.)

18060 PRESSURE OF SATURATED VAPORS OF VCl_2 . M. A. Oranskaya and I. L. Perfilova (Leningrad State Univ.). *Zhur. Neorg. Khim.*, 6: 257-8 (1961). (In Russian)

The vapor pressure of VCl_2 at 910 to 1100°C was determined, and the enthalpy and entropy of sublimation were evaluated. VCl_2 neither disproportionates nor dissociates at temperatures up to 1126°C. Above 1100°C, VCl_2 begins to react with quartz forming V_2O_5 as one of the reaction products. (R.V.J.)

18061 DISPROPORTIONATION OF VCl_3 . M. A. Oranskaya, Yu. S. Lebedev, and I. L. Perfilova (Leningrad State Univ.). *Zhur. Neorg. Khim.*, 6: 259-60 (1961). (In Russian)

The disproportionation $2 VCl_3(solid) \rightarrow VCl_4(gas) + VCl_2(solid)$ was studied at temperatures from 300 to 700°C. In dry oxygen-free environment the disproportionation becomes noticeable at 425°C. The enthalpy and entropy of disproportionation were evaluated. (R.V.J.)

18062 MAGNETIC SUSCEPTIBILITY OF VANADIUM SULFIDES AT ELEVATED TEMPERATURES. G. M. Loginov (Leningrad State Univ.). *Zhur. Neorg. Khim.*, 6: 261-4 (1961). (In Russian)

The magnetic susceptibility of vanadium sulfides ($VS_{1.02}$

to $VS_{1.50}$) was measured at 20 to 500°C, and the presence of a two-phase region was confirmed for $VS_{1.22}$ to $VS_{1.33}$. The Curie and Weiss law holds for V_2S_3 ; $VS_{1.33}$ has a very weak antiferromagnetic Curie point, while the antiferromagnetic reaction V^{II} to V^{III} is inherent to the $VS_{1.02}$ to $VS_{1.22}$ phase. (R.V.J.)

18063 ON DISPROPORTIONATION REACTION OF PENTAVALENT MOLYBDENUM IN ALKALI MEDIUM. Ya. R. Katsobashvili, N. S. Kurkova, and E. A. Levitskii. Zhur. Neorg. Khim., 6: 265-7 (1961). (In Russian)

The causes for Mo transition into solution from precipitated $Mo(OH)_5$ in an alkali medium were analyzed. It is shown that Mo^{5+} is oxidized to Mo^{6+} , precipitating $Mo(OH)_3$ and the Mo^{6+} going into solution. The reversibility of $2 Mo^{5+} + Mo^{3+} \rightleftharpoons 3 Mo^{6+}$ depends on solution pH. (R.V.J.)

18064 COMPLEX ZIRCONIUM OXALATES. A. A. Grinberg and V. I. Astapovich. Zhur. Neorg. Khim., 6: 321-9 (1961). (In Russian)

A normal zirconium oxalate and complex zirconium potassium oxalate were prepared and their chemical and physical properties were studied. The dissociation of the complex ion was determined to follow $Zr(C_2O_4)_4^{4-} \rightleftharpoons Zr(C_2O_4)_3^{3-} + C_2O_4^{2-}$, or more accurately $Zr(C_2O_4)_4^{4-} + 2 H_2O \rightleftharpoons Zr(C_2O_4)_3 \cdot (H_2O)_2^{3-} + C_2O_4^{2-}$. (R.V.J.)

18065 SYNTHESIS OF ZIRCONOMOLYBDENUM HETERO-POLY OXIDES. Z. F. Shakhova, E. N. Semenovskaya, and E. N. Timofeeva. Zhur. Neorg. Khim., 6: 330-3 (1961). (In Russian)

The ammonium and cesium salts of zirconomolybdenum heteropoly acid were prepared and analyzed. Zirconium molybdenum heteropoly acid was developed chromatographically using cation KU-2, and a method was developed for determining zirconomolybdenum heteropoly-acids and salts. (R.V.J.)

18066 ON GADOLINIUM FERROCYANIDES. M. A. Glushkova and S. M. Petushkova. Zhur. Neorg. Khim., 6: 349-53 (1961). (In Russian)

The reaction of $GdCl_3$ with Li, Na, K, Rb, and Cs ferrocyanides was studied by the method of solubility, electromotive force, and analysis of solids. The reaction of Gd^{3+} with $Li_4[Fe(CN)_6]$ forms a simple $Gd_4[Fe(CN)_6]_3$. The reaction of $GdCl_3$ with sodium ferrocyanide takes place in two stages. At the beginning of the reaction, up to the ratio $Na_4[Fe(CN)_6] : GdCl_3 = 0.75$, $Gd_4[Fe(CN)_6]_3$ is formed followed by further reaction resulting in $NaGd[Fe(CN)_6]$. The reactions of $GdCl_3$ with K, Rb, and Cs ferrocyanides result in compounds of a type $MGd[Fe(CN)_6]$ ($M = K, Rb$, and Cs). The solubilities of $Gd_4[Fe(CN)_6]_3$, $NaGd[Fe(CN)_6]$, $KGd[Fe(CN)_6]$, $RbGd[Fe(CN)_6]$, and $CsGd[Fe(CN)_6]$ in water at 25°C are 1.6×10^{-4} , 6×10^{-4} , 2.2×10^{-4} , and 2.8×10^{-4} mol/l. (R.V.J.)

18067 URANYL OXALATORHODANINE COMPOUNDS. V. P. Markov and T. V. Sergeeva. Zhur. Neorg. Khim., 6: 368-75 (1961). (In Russian)

An analysis is made of nine mixed uranyl oxalatorhodanine compounds $NH_4[UO_2C_2O_4CNS(H_2O)_2]$, $K[UO_2C_2O_4CNS(H_2O)_2]$, $Cs[UO_2C_2O_4CNS(H_2O)_2]$, $(NH_4)_4[(UO_2)_2(C_2O_4)_3(CNS)_2(H_2O)_2]$, $K_4[(UO_2)_2(C_2O_4)_3(CNS)_2(H_2O)_2]$, $Cs_4[(UO_2)_2(C_2O_4)_3(CNS)_2(H_2O)_2]$, $(CN_3H_3)_3[UO_2(C_2O_4)_2CNS]$, $Ba_3[UO_2(C_2O_4)_2CNS]_2 \cdot 8 H_2O$, and $Ba_2[UO_2(C_2O_4)_2(CNS)_2] \cdot 6 H_2O$. It is shown that the stability of oxalatorhodanine in aqueous solutions increases with oxalate group numbers inside the compound $(C_2O_4)^{2-} : U = 1:1, 1:1.5$, and $1:2$ with the exception of $Ba_2(UO_2(C_2O_4)_2(CNS)_2) \cdot 6 H_2O$. The reaction of guanidine and barium thiocyanate with uranyl monoxalate

results in uranyl dioxalate. It is shown that rhodanine group content in uranyl oxalatorhodanine has the ratio $U : CNS^- = 1:1$, with the exception of $Ba_2[UO_2(C_2O_4)_2(CNS)_2] \cdot 6 H_2O$. (R.V.J.)

18068 SYNTHESIS OF COMPLEX MONOCARBONATES OF $Me^+ [UO_2(OH)CO_3(H_2O)_3]$ TYPE. I. I. Chernyaev, V. A. Golovnya, and G. V. Ellert. Zhur. Neorg. Khim., 6: 376-85 (1961). (In Russian)

A method was developed for separating solid complex compounds of the second type in the uranyl carbonate genetic series $NH_4[UO_2(OH)CO_3(H_2O)_3]$. Ammonium, thallium, silver and barium monocarbonate hydroxytrihydro uranyls were separated and determined. It is shown that aqueous solutions of $(NH_4)_4[UO_2(CO_3)_3]$ possess a higher stability to hydrolysis than $K_4[UO_2(CO_3)_3]$ and $Na_4[UO_2(CO_3)_3]$. (R.V.J.)

18069 SYNTHESIS OF $Me_3^+ [(UO_2)_2(OH)(CO_3)_3(H_2O)_5]$ COMPOUNDS. I. I. Chernyaev, V. A. Golovnya, and G. V. Ellert (Kurnakov Inst. of General and Inorganic Chemistry, Academy of Sciences, USSR). Zhur. Neorg. Khim., 6: 386-93 (1961). (In Russian)

Potentiometric titrations of ammonium uranyl tricarbonate by hydrochloric acid and uranyl nitrate indicated the presence of compounds with mole ratios $U : CO_3 = 1:2.5, 1:2.0, 1:1.5$, and $1:1.0$. Complex carbonate compounds of the type $(NH_4)_3[(UO_2)_2(OH)(CO_3)_3(H_2O)_5]$ were prepared and composition and properties of derivatives $Ba_3[(UO_2)_2(OH)(CO_3)_3(H_2O)_5]_2 \cdot 4 H_2O$, $Ag_3[(UO_2)_2(OH)(CO_3)_3(H_2O)_5]$, and $Tl[(UO_2)_2(OH)(CO_3)_3(H_2O)_5]$ were determined. (R.V.J.)

18070 ON THE PREPARATION AND PROPERTIES OF $(NH_4)_6Th(CO_3)_5 \cdot 3 H_2O$. I. I. Chernyaev, V. A. Golovnya, and A. K. Molodkin. Zhur. Neorg. Khim., 6: 394-9 (1961). (In Russian)

The preparation and properties of $(NH_4)_6Th(CO_3)_5 \cdot 3 H_2O$ are described. An ion exchange reaction indicates that pentacarbonate compounds of the $Me_6Th(CO_3)_5 \cdot n H_2O$ type evolve in nitrate or thorium hydroxide ammonium-carbonate solutions. The strength of the pentacarbonate depends on the cation and increases according to $[(NH_4)_6]^{6+} < [Co(NH_3)_6]^{6+} < [CN_3H_3]_3(NH_4)_3^{6+} < Ti_6^{6+}$. (R.V.J.)

18071 SOLUBILITY OF CALCIUM TUNGSTATE IN AQUEOUS LITHIUM CHLORIDE SOLUTIONS AT ELE-VATED TEMPERATURES. M. I. Ravich and L. F. Yastrebova. Zhur. Neorg. Khim., 6: 431-7 (1961). (In Russian)

The solubility of $CaWO_4$ in concentrated hydrous LiCl solutions at 300 to 500°C exceeds by an order of two or more the solubility in pure water. $CaWO_4$ solubility in LiCl is congruent in character. The solubility in 30 wt.% LiCl solution at 300 to 500°C increases with increased LiCl or with increased temperature. There is a direct relation between the relatively high solubility at high temperature in concentrate solutions and the solubility in molten LiCl. (R.V.J.)

18072 PHYSICO-CHEMICAL ANALYSIS OF $Zr(SO_4)_2$ REACTION WITH CERTAIN ORGANIC ACIDS IN HYDROUS MEDIUM. A. Ya. Deich. Zhur. Neorg. Khim., 6: 438-42 (1961). (In Russian)

A physico-chemical analysis was made of the systems $Zr(SO_4)_2 - C_6H_7(OH)_4 COOH - H_2O$, $Zr(SO_4)_2 - HOOC - CH = CH - COOH - H_2O$, and $Zr(SO_4)_2 - HO_3S - C_6H_3(OH) COOH - H_2O$ considering the density, viscosity, and surface intensity at 20°C and 0.1 g/mol/l. A chemical interaction of components producing dissociated molecular compounds was observed in $Zr(SO_4)_2 - C_6H_7(OH)_4 COOH - H_2O$ and $Zr(SO_4)_2 - HO_3S - C_6H_3(OH) COOH - H_2O$ systems, while in

$\text{Zr}(\text{SO}_4)_2 - \text{HOOC} - \text{CH} = \text{CH} - \text{COOH} - \text{H}_2\text{O}$ chemical interactions were not observed. (R.V.J.)

18073 MAGNETIC SUSCEPTIBILITY OF URANYL COMPOUNDS. V. I. Belova, Ya. K. Syrkin, V. P. Markov, and I. V. Isapkina (Kurnakov Inst. of General and Inorganic Chemistry, Academy of Sciences, USSR). Zhur. Neorg. Khim., 6: 495-7(1961). (In Russian)

The magnetic susceptibilities of 26 complex uranyl compounds (UO_2SO_4 , $\text{UO}_2(\text{NO}_3)_2$, UO_2Cl_2 , and $\text{UO}_2\text{C}_2\text{O}_4$ with various molecular increments) were determined at room temperature and at liquid nitrogen temperature. The tabulated results exhibit weak paramagnetism for UO_2^{2+} in all cases. The table also shows the susceptibility for the "initial" uranyl compounds calculated by subtracting the diamagnetic susceptibility of water, urea, or acetamide from the molar susceptibility of the respective compounds. The Van Fleck paramagnetism per uranyl group in anhydrous UO_2SO_4 is 46×10^{-6} , while for all other uranyl compounds the magnitude is near $(65 \pm 6) \times 10^{-6}$. For nitrate compounds, $\chi_{\text{UO}_2^{2+}} = (61 \pm 14) \times 10^{-6}$; for chlorides, $(65 \pm 2) \times 10^{-6}$; for oxalates with urea or acetamine, $(61 \pm 1) \times 10^{-6}$; and for complex compounds with various addends where uranyl is a part of the anion, $(79 \pm 13) \times 10^{-6}$. (R.V.J.)

18074 REGULARITIES IN STRONTIUM SCAVENGING BY IRON HYDROXIDE AND ACTIVE MANGANESE DIOXIDE IN HYDROUS SOLUTIONS. Yu. V. Egorov, V. V. Pushkarev, and E. V. Tkachenko (Kirov Urals Polytechnic Inst., [USSR]). Zhur. Neorg. Khim., 6: 505-7(1961). (In Russian)

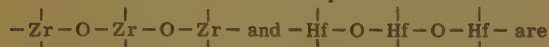
Langmuir isotherms show that strontium scavenging by $\text{Fe}(\text{OH})_3$ and active Mn_2O_2 at pH 12 results in ferrite and manganese type compounds with a strontium molar ratio of 1:2 at saturation. The chemical sorption of Sr by $\text{Fe}(\text{OH})_3$ and active Mn_2O_2 is achieved by ion exchange of Sr and sorbent hydrogen. It is postulated that Sr appears in the exchange reaction as SrCl^+ . (R.V.J.)

18075 COMPETITION BETWEEN MAGNESIUM AND MICRO-QUANTITIES OF STRONTIUM IN IRON HYDROXIDE SCAVENGING IN STRONG ALKALI MEDIUM. Yu. V. Egorov, V. V. Pushkarev, E. V. Tkachenko, and V. M. Nikolaev (Kirov Urals Polytechnic Inst., [USSR]). Zhur. Neorg. Khim., 6: 508-9(1961). (In Russian)

The character of Mg competition with Sr in $\text{Fe}(\text{OH})_3$ scavenging at pH 12 is described by the law of chemical kinetics. It is assumed that amorphous ferrite compounds form during both $\text{Fe}(\text{OH})_3$ and MnO_2 precipitation. (R.V.J.)

18076 THE INVESTIGATION OF MACROQUANTITIES OF ZIRCONIUM AND HAFNIUM IN AQUEOUS HYDROCHLORIC SOLUTIONS. V. M. Kolskov. Zhur. Priklad. Khim., 34: 512-16(Mar. 1961). (In Russian)

The absorption spectra of Zr and Hf in HCl solutions were analyzed, and their polymerization was studied in an effort to find a method for Zr separation. The structures



are suggested for Zr and Hf concentrations of 0.04 and 0.025 mole/l respectively, appearing as polymers in hydrochloric solutions. An increase in Zr concentration increases the molecular weight of polymers. The absorption band $\text{ZrOCl}_2 \cdot 8\text{H}_2\text{O}$, evident in the solution at 207 to 260 μ , results from a reaction between Zr and Cl; Zr alone does not absorb at this range. The absorption groups in $\text{ZrOCl}_2 \cdot 8\text{H}_2\text{O}$ contain 1 atom of Zr and n atoms of Cl (n is of the order of several units). The concentration of absorption groups increases with the increase of chloride. Hafnium

solutions do not exhibit absorption bands at 207 to 350 μ . (R.V.J.)

18077 VACUUM-THERMAL METHOD OF PREPARING CERIUM AND LANTHANUM MONOSULFIDES. S. V. Radzikovskaya and G. V. Samsonov (Inst. of Metal Ceramics and Special Alloys, Academy of Sciences, Ukr. SSR). Zhur. Priklad. Khim., 34: 671-2(Mar. 1961). (In Russian)

The reaction $\text{Ce}_2\text{S}_3 + \text{CeO}_2 + 2\text{C} = 3\text{CeS} + 2\text{CO}$ at 1000 to 1700°C produced a sulfide close to CeS but required a second heating at 1650°C for 1 hour with Ce_2S_3 saturation to purify the product. The reaction $2\text{La}_2\text{S}_3 + \text{La}_2\text{O}_3 + 3\text{C} = 6\text{LaS} + 3\text{CO}$ produced LaS of stoichiometric content without La_2S_3 saturation, however, it also required a second vacuum heating at 1650°C. Both monosulfides are golden-yellow in color. (R.V.J.)

18078 HYDROGEN AND DEUTERIUM PENETRATION THROUGH NICKEL FILM AT 250 TO 600°C. Yu. I. Belyakov (Beljakov) and N. I. Ionov (Ioffe Inst. of Physics and Tech., Leningrad). Zhur. Tekh. Fiz., 31: 204-10(Feb. 1961). (In Russian)

The permeability of Ni membranes to hydrogen and deuterium at 250 to 600°C was studied mass spectrometrically. The temperature dependence of permeability, diffusion, and solubility was determined. The diffusion properties of a hydrogen-nickel system change quickly at the Curie point. The observed isotope effects are explained by the variability of H_2 and D_2 molecular dissociation energies and by characteristic oscillation frequencies. (tr-auth)

Radiation Chemistry and Radiochemistry

18079 (CEA-1758) SEPARATION DES PRODUITS DE FISSION PAR UTILISATION DU RECOL. (Separation of Fission Products by the Use of Recoil). Robert Henry, Jacqueline Beydon, and André Bardy (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1960. 18p.

Fission recoil studies were made in U_3O_8 -organic solvent mixtures. The organic phase chosen was first naphthalene then terphenyl. Graphite and activated carbon were tried out as recoil media. It was first verified that the fission fragments are ejected from the uranium oxide particles under the experimental conditions. The retention phenomenon observed is caused by an adsorption occurring either during irradiation or during the chemical treatment. Using naphthalene or terphenyl, the individual separation of the fission products has made it possible to show the influence of the chemical nature of the recoil medium on the retention of each fission product. A hypothesis was presented concerning the phenomenon: experiments carried out using "scavengers," together with kinetic studies make it possible to explain the retention phenomenon and to choose the most favorable conditions for reducing the retention to a low value. The thermal recombination kinetics demonstrate the influence of the fission-ion charge on the final value of the retention for a given temperature. The origins of the thermal recombination are discussed. (auth)

18080 (IFA-CS-21) RADIATION INDUCED CHEMISORPTION OF OXYGEN ON CHROMIA. Manfred Nachman, Ion Maxim, and Tiberiu Braun (Academia R. P. R. Institutul de Fizica Atomica, Bucharest). 1960. 16p.

The effect of nuclear radiation on the chemisorption of oxygen on Cr_2O_3 , $\text{Cr}_2\text{O}_3 - \text{Al}_2\text{O}_3$, and $\text{Cr}_2\text{O}_3 - \text{SnO}_2$ catalysts

was studied. An iodometric method was used to measure the amount of chemisorbed oxygen. Simultaneously the increase in the catalytic activity of the catalyst in the decomposition of H_2O_2 was determined. It was found that the radiation present within a nuclear reactor promotes the chemisorption of oxygen on chromia (either pure or supported an Al_2O_3 or SnO_2) at temperatures at which such a chemisorption does not normally occur. The radiochemisorption of oxygen on chromia increases with the degree of dispersion of chromia on Al_2O_3 or SnO_2 and is accompanied by an increased catalytic activity of this catalyst in the decomposition reaction of H_2O_2 . It seems that radiochemisorption is largely due to the action of γ rays and fast neutrons on the gas. (auth)

18081 (NAA-SR-99(Del.)) TRITIUM PRODUCTION. Arnold Belton (North American Aviation, Inc., Downey, Calif.). Sept. 14, 1950. Decl. with deletions Mar. 8, 1960. 27p. Contract AT-11-1-GEN-8.

Tritium produced by the reaction $\text{Li}^6(n, \alpha)\text{T}$ is contaminated by hydrogen. Part of the hydrogen is occluded in the lithium initially and the remainder is generated by the reaction $\text{He}^3(n, p)\text{T}$, where He^3 comes from $\text{T} \rightarrow \text{He}^3 + e^-$. Calculations were made of the tritium yields, percentage hydrogen impurity, and the energetics of the reactions for various values of flux and time. For all cases in which there is initial occluded H_2 , the impurity passes through a minimum. It is shown that for fluxes of the order of 10^{12} , the depletion of Li^6 must be considered. (auth)

18082 (NAS-NS-3029) THE RADIOCHEMISTRY OF RUTHENIUM. E. I. Wyatt and R. R. Rickard (Oak Ridge National Lab.). Feb. 1961. 106p.

"Nuclear Science Series" of the National Research Council. Committee on Nuclear Science.

18083 (NAS-NS-3031) THE RADIOCHEMISTRY OF THE TRANSCURIUM ELEMENTS. G. H. Higgins (Univ. of California. Lawrence Radiation Lab.). Oct. 25, 1960. 42p.

"Nuclear Science Series" on the National Research Council. Committee on Nuclear Science.

18084 (NAS-NS-3032) THE RADIOCHEMISTRY OF ALUMINUM AND GALLIUM. John E. Lewis (Aluminum Co. of America, New Kensington, Penna.). [1961].

"Nuclear Science Series" of the National Research Council. Committee on Nuclear Science.

A review of the nuclear and chemical features of these elements which are of particular interest to the radiochemist is presented. A discussion is also included on aspects of sample dissolution and counting techniques followed by a collection of radiochemical procedures for the elements as found in the literature. (J.R.D.)

18085 (NYO-9418) A COMPARISON OF RADIATION-INDUCED GRAFT COPOLYMERIZATION UTILIZING ELECTRON ACCELERATORS AND ISOTOPE SOURCES AS RADIATION INITIATORS. Quarterly Report for the Period January 18 to April 17, 1961. (Radiation Applications Inc., Long Island City, N. Y.). May 8, 1961. Contract AT(30-1)-2636. 22p.

Graft polymers were made by Co^{60} mutual irradiation of mixtures of styrene and methyl acrylate in contact with Teflon. These graft copolymers were analyzed by infra-red absorption and their composition determined. The composition of the graft copolymer formed from styrene and methyl acrylate was different from that which is predicted by the copolymer composition equation. The rate of grafting of methacrylic acid; styrene to polypropylene film using Van de Graaff electron accelerator at four dose rates

was determined. The dose rate dependency was found to be slightly lower than the half order found for the same system under Co^{60} initiation. An infra-red analytical technique was used to compare the graft copolymer composition from the two methods of grafting initiation. (auth)

18086 (OOR-007:7) FLUOROCARBON N-F COMPOUNDS. Quarterly Technical Report No. 7. J. A. Young and R. D. Dresdner (Florida. Univ., Gainesville. Engineering and Industrial Experimental Station). 1960. DA-01-009-ORD-772. 17p.

Perfluoropentadiene-1,4 failed to react with NF_3 ; however, it was found that this diene was isomerized by cesium fluoride, over a wide temperature range, to perfluoropentyne-2. The pentyne could be polymerized by gamma irradiation. A study was made of the isomerization of C_5F_8 isomers over selected catalysts. Interrelationships were established for the fluorocarbons pentyne-2, 1-methylcyclobutene, 3-methylcyclobutene, cyclopentene, pentadiene-1,3 and pentadiene-1,4. Both $\text{CF}_3\text{CF}=\text{CF}_2$ and $\text{CF}_3\text{N}=\text{CF}_2$ were found at least to dimerize over cesium fluoride. The propylene dimers are thought to have the structures $(\text{CF}_3)_2\text{C}=\text{C}(\text{CF}_3)_2$ and $(\text{CF}_3)_2\text{CFCF}=\text{CFCF}_3$. Definite indications of the successful synthesis of a fluorocarbon diacyldiimide, $\text{CF}_3\text{CON}=\text{NOCF}_3$, have been obtained. The compound is rather unstable even at room temperature, and as anticipated, gives C_2F_4 on thermal decomposition. Triamides containing fluorocarbon groups were made by reaction between N-bromolamides and acyl halides, in yields ranging from very poor to good. Compounds with three small perfluoroacyl groups apparently cannot be made by this method. The reaction between acyl halides and $(\text{CF}_3)_2\text{N}_2\text{Hg}$, on the other hand, gives amides of the structure $\text{RCON}(\text{CF}_3)_2$ in good yield with all acyl halides tested except phosgene. Tetrakis-(trifluoroacetyl)hydrazine on heating to 300° is converted to 3,5-bis(trifluoromethyl)oxadiazole, plus trifluoroacetic anhydride. (auth)

18087 (PAN-192/XIII) METOD POLUCHENIYA SERY S^{35} V VIDE $\text{H}_2\text{S}^{35}\text{O}_4$ (BEZ NOSITELYA). (Preparation of $\text{H}_2\text{S}^{35}\text{O}_4$ With High Radiochemical Purity). M. Kukharski and R. Pleevski (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). 1960. 15p.

The preparation of carrier-free S^{35} sulfuric acid on an industrial scale is described. S^{35} is produced by the reaction $\text{Cl}(n, p)\text{S}^{35}$ in KCl-target bombardment by 10^{13} n/cm²/sec for 4 weeks. Mixtures of K^{42} , Cl^{36} , Cl^{38} , and especially P^{32} are separated by precipitation with $\text{Fe}(\text{OH})_3$. The organic admixtures are burned out by adding 3% H_2O_2 solution. The resulting product is sufficiently chemically and radiochemically pure for medical purposes. (R.V.J.)

18088 (PAN-193/XII) POLUCHENIE SULFATOV MECHENYKH SEROI S-35. (Preparation of S-35 Labelled Sulfates). M. Kukharski, A. Pasternak, and R. Pleevski (Polish Academy of Sciences, Inst. of Nuclear Research, Warsaw). 1960. 9p.

Labeled sodium and potassium sulfates were prepared by ion exchange. The prepared product, carrier-free $\text{H}_2\text{S}^{35}\text{O}_4$, is radiochemically and chemically suitable for medical applications. (R.V.J.)

18089 (RRL-58) PRIMARY STEPS IN THE PHOTOLYSIS OF METHYL CARBONATE. M. H. J. Wijnen (Mellon Inst. Radiation Research Labs., Pittsburgh). Apr. 21, 1961. Contract AT(30-1)-2310. 8p. (NYO-9393)

The photolysis of methyl carbonate was investigated at 6 and 80°C at various pressures and intensities. The major part of the primary process is given as: $(\text{CH}_3\text{O})_2\text{CO} + h\nu \rightarrow \text{CH}_3 + \text{CO}_2 + \text{CH}_3\text{O}$, or $\rightarrow \text{CH}_4 + \text{CO}_2 + \text{CH}_2\text{O}$. Steps such as:

$(\text{CH}_3\text{O})_2\text{CO} + h\nu \rightarrow 2\text{CH}_3\text{O} + \text{CO}$ and/or $\rightarrow \text{CH}_3\text{OH} + \text{CO} + \text{CH}_2\text{O}$ occur to some extent. (auth)

18090 (USNRDL-TR-501) USE OF EPR IN RADIATION CHEMISTRY. T. H. Anderson and R. S. Alger (Naval Radiological Defense Lab., San Francisco). Mar. 3, 1961. 22p.

The electron paramagnetic resonance spectra of free radicals produced in radiation chemical processes serve to characterize these intermediates both qualitatively and quantitatively. Theoretical and experimental details of obtaining and interpreting such spectra are discussed. (auth)

18091 (WAPD-BT-22(p.31-43)) FAST ELECTRON AND GAMMA IRRADIATIONS OF POTASSIUM TETRABORATE, AMMONIUM PENTABORATE, AND BORIC ACID SOLUTIONS. J. M. Wright and T. R. Druga (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

The effects of radiation on potassium tetraborate, ammonium pentaborate, and boric acid solutions were investigated. Fast electron radiation decomposed potassium tetraborate solutions into H_2 , O_2 , and H_2O_2 , but preirradiation hydrogen additions virtually eliminated gas production up to a total dose of 2.7×10^8 rads. The ammonium pentaborate solutions, even with added hydrogen, proved to be unstable to radiation, producing large quantities of H_2 , O_2 , H_2O_2 , and NH_3 while the boric acid proved quite stable, yielding only small amounts of H_2 up to 6.8×10^7 rads. (auth)

18092 (CEA-tr-R-534) QUELQUES PROBLEMES DE LA TECHNIQUE DE L'EXPERIMENTATION RADIOCHIMIQUE. (Some Problems with the Technique of Radiochemical Experimentation). A. A. Goriunov (Goriounov). Translated into French from Zhur. Anal. Khim., 11: 590-8(1956). 25p.

A series of auxiliary devices for radiochemical experimentation is described. They are: a protective cover for counting chambers, a vertical case for Al absorbers, celluloid capsules, a pressing mold and heater for molding celluloid capsules, and an evaporator for drying radioactive samples. This equipment has given good results in use and is recommended. (T.R.H.)

18093 (JPRS-9076) EFFECTS OF FILLERS ON THE RADIATION RESISTANCE OF PLASTICIZED POLYVINYL CHLORIDE. L. P. Yanova, M. S. Monastyrskaya, S. A. Pavlov, and T. T. Gorbateva. Translated from Izvest. Vysshikh Ucheb. Zavedenii, Tekhnol. Legkoi Prom., No. 4, 46-52(1960). 14p.

The effects of x rays on the strength and thermo-mechanical properties of polyvinyl chloride films, containing fillers and various plasticizers were investigated. Dibutyl phthalate, dioctyl phthalate, dioctyl sebacinate, and a mixture of higher isocohol phthalates were used as the plasticizers. Graphite, iron, and aluminum were the fillers used. The strength of all unfilled samples increased when they were exposed to relatively small radiation doses (6 hrs) due to the interlocking of the polymers. The tensile strength of all samples, with the exception of those filled with graphite, started to fall as the radiation dose was increased to 12 hrs. The materials were destroyed when exposed to radiation doses of 22 hrs; the surfaces of the samples became viscous and their color changed from light yellow to dark brown. It was established that the process of structure formation of plasticized films increased with the increase in radiation doses. The introduction of graphite and lead increased the radiation stability of the plasticized films. It was established that

even small admixtures of lead in plasticized films provoke a dispersal of energy over a great number of bonds in the chains of the principal valences of polyvinyl chloride. (M.C.G.)

18094 STUDIES ON TRITIUM LABELED COMPOUNDS. II. PREPARATION OF TRITIUM LABELED STEARIC ACID. Yoshishige Sato, Teruhiko Meshi, and Tadao Takahashi (Tanabe Seiyaku Co., Ltd., Osaka). Bull. Chem. Soc. Japan, 34: 167-9(Feb. 1961). (In English)

Chemical reduction, exchange, electric discharge, and recoil labeling methods were applied for preparing tritium labeled stearic acid. As a result of the recoil labeling, the irradiated stearic acid was found to contain high destruction products which are mainly composed of esters of fatty acid. (auth)

18095 STUDIES ON TRITIUM LABELED COMPOUNDS. IV. PREPARATION OF TRITIUM LABELED ALANINE BY MEANS OF ELECTRIC DISCHARGE. Yoshishige Sato and Tadao Takahashi (Tanabe Seiyaku Co., Ltd., Osaka). Bull. Chem. Soc. Japan, 34: 169-70(Feb. 1961). (In English)

To obtain tritium labeled alanine of a high specific activity by means of electric discharge, α -hydroximinopropionic acid was employed in place of alanine. After electric discharge, tritium labeled α -hydroximinopropionic acid was removed by ether extraction and the residue was chromatographed. Tritium labeled alanine was obtained with a specific activity of $4.4 \mu\text{C}/\text{mg}$, two hundred times as great as that obtained by the use of alanine. (auth)

18096 STUDIES ON HEAVY-NITROGEN LABELED COMPOUNDS. III. PREPARATION OF ^{15}N -LABELED α -HYDROXIMINOPROPIONIC ACID. Yoshishige Sato, Teruhiko Meshi, and Norio Sugimoto (Tanabe Seiyaku Co., Ltd., Osaka). Bull. Chem. Soc. Japan, 34: 243-4(Feb. 1961). (In English)

Using KN^{15}O_3 as a starting material, α -hydroximinopropionic acid- N^{15} was synthesized in accordance with the following reactions: $\text{KN}^{15}\text{O}_3 \rightarrow \text{KN}^{15}\text{O}_2 \rightarrow \text{N}^{15}\text{H}_2\text{OH} \rightarrow \text{CH}_3\text{C}(=\text{N}^{15}\text{OH})\text{COOH}$. These reactions were carried out without separating any intermediate products. The yield of α -hydroximinopropionic acid- N^{15} was about 61% on the basis of KN^{15}O_3 . (auth)

18097 SELECTIVITY IN RADIATION-INDUCED CROSSLINKING AND SCISSION OF POLYVINYL ALCOHOL (PVA). Yutaka Hirano and Ayao Amemiya (Tokyo Univ.). Bull. Chem. Soc. Japan, 34: 292-3(Feb. 1961). (In English)

Only special types of bonds, such as the 1,2-glycol type which exists initially in usual samples, can be fractured selectively in either dry or swollen samples. Also, bonds formed by crosslinking in dry samples are definitely of the special types that are susceptible to oxidation by periodic acid. But in swollen samples there are at least two kinds of bonds formed by crosslinking, one susceptible and one not susceptible to oxidation. The changes in the limiting viscosity number of irradiated PVA before and after oxidation by HIO_4 plotted against radiation dose are shown. (N.W.R.)

18098 THE EFFECT OF BETA-DECAY ON THE EXCHANGE PROPERTIES OF THE RARE EARTH-EDTA COMPLEX IONS. P. Glentworth and R. H. Betts (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Chem., 39: 1049-53(May 1961). (AECL-1213)

It is shown that Yb^{3+} is very resistant toward ordinary thermal exchange when it is complexed with the chelating agent EDTA in aqueous solution. However, when the complexed rare earth atom, as the 1.8-h Yb^{177} , emits a beta

particle, the daughter atom Lu^{177} escapes readily from the chelate structure. Nuclear recoil arising from the beta emission is shown not to be the cause of the escape of the daughter atom. It is suggested that the observed lability of the daughter atom is a result of a high degree of chemical reactivity of the chelate ion arising from the sudden change in atomic number of the central metal ion of the chelate structure. (auth)

18099 ROOM TEMPERATURE STABILIZATION OF RADIATION-PRODUCED FREE RADICALS IN BARBITURIC ACIDS. J. A. R. Cloutier (National Health and Welfare, Ottawa). *Can. J. Phys.*, 39: 514-33 (Apr. 1961).

It is shown that a boric acid glass may be used to stabilize, at room temperature, organic free radicals produced by radiation in a number of barbituric acid derivatives. The method and results are discussed. (auth)

18100 RADIOACTIVE CATALYSTS. THE DEHYDRATION OF CYCLOHEXANOL WITH A MIXTURE OF MAGNESIUM SULFATE AND CALCIUM CHLORIDE AS A CATALYST. A. A. Balandin, Vikt. I. Spitsyn, N. P. Dobrosel'skaya, and I. E. Mikhailenko (Inst. of Physical Chemistry, Academy of Sciences, USSR). *Doklady Akad. Nauk S.S.S.R.*, 137: 628-30 (Mar. 21, 1961). (In Russian)

It had been previously shown that the presence of S^{35} ($E_{\text{max}} = 0.167$ Mev) in a MgSO_4 catalyst improved the yield in the dehydration of cyclohexanol. The introduction of Ca^{45} ($E_{\text{max}} = 0.254$ Mev) as CaCl_2 to MgSO_4 resulted in a rise of catalytic activity in all cases, although pure CaCl_2 , even with a high content of Ca^{45} (93.7 mc/g), is inert as a catalyst. The increase in the degree of conversion at a given temperature was found to depend linearly on the log of the radiation dose imparted to the catalyst by S^{35} or Ca^{45} . Excitation of the catalyst by bombardment with beta particles improves the kinetics of the process. The apparent activation energy is decreased with the use of radioactive catalysts. (TTT)

18101 THE RADIATION CHEMISTRY OF AZIDE SOLUTIONS. PART I. THE ACTION OF X-RAYS (200 kv) ON DEAERATED AQUEOUS SOLUTIONS OF SODIUM AZIDE. P. Kelly and M. Smith (King's Coll., Newcastle upon Tyne, Eng.). *J. Chem. Soc.*, 1479-87 (Apr. 1961).

The principal products produced in the radiolysis (200 kv x rays) of aqueous solutions of sodium azide at pH 8.0, in the absence of oxygen, are nitrogen and ammonia, the yields of which vary markedly with the azide concentration. The results are shown to be accommodated by a mechanism in which both the oxidizing and the reducing species produced by the interaction of the ionizing radiation with water react with the azide ion, leading to the N_3 radical and to nitrogen and the NH^- ion, respectively. The N_3 radical is found to be stable with respect to its self-dissociation. (auth)

18102 THE RADIATION CHEMISTRY OF AZIDE SOLUTIONS. PART II. THE ACTION OF X-RAYS (200 kv) ON DEAERATED AQUEOUS SOLUTIONS OF SODIUM AZIDE IN THE PRESENCE OF DIFFERENT ORGANIC SOLUTES. P. Kelly and M. Smith (King's Coll., Newcastle upon Tyne, Eng.). *J. Chem. Soc.*, 1487-94 (Apr. 1961).

Deaerated aqueous solutions of sodium azide were irradiated with x rays (200 kv) in the presence of methanol, propan-2-ol, acetone, and formaldehyde. The azide-methanol solutions were studied over a wide range of concentrations; in all cases the main reaction products were: nitrogen, ammonia, hydrogen, ethylene glycol, and formaldehyde. The results confirm the mechanism for radiolytic decomposition of the azide ion previously presented. Studies on the azide-propan-2-ol and azide-acetone systems pro-

vide confirmatory evidence for the assumption of H_2O^- (polaron) as a primary species in the radiolysis of water. (auth)

18103 ELECTRON SPIN RESONANCE SPECTRA OF γ -IRRADIATED CARBOHYDRATES AND α -HYDROXY ACIDS. A. J. Bailey, S. A. Barker, J. S. Brimacombe, D. Pooley, and D. H. Spence (The University, Birmingham, Eng.). *Nature*, 190: 259-60 (Apr. 15, 1961)

Reaction mechanisms involved in the production of polymers from irradiated de-aerated aqueous solutions of carbohydrates and α -hydroxy acids were studied. Polycrystalline carbohydrate and α -hydroxy acid samples in evacuated glass phials were exposed to a Co^{60} γ source and the radicals obtained were identified by means of electron spin resonance spectra. Data are tabulated on type of spectrum, peak separation, and postulated radical formed. Results are interpreted. (C.H.)

18104 TEMPERATURE EFFECTS ON THE FORMATION OF FREE RADICALS IN THE AMINO ACIDS. Frank Patten and Walter Gordy (Duke Univ., Durham, N. C.). *Radiation Research*, 14: 573-89 (May 1961).

Investigations show that the free radicals obtained at room temperature in the amino acids are generally not the same as those found when the sample is irradiated at the much lower temperature of liquid nitrogen, 77°K. However, when the sample is irradiated at the lower temperature and allowed to warm to room temperature, the radical obtained is usually the same as that produced by irradiation at room temperature. It thus appears that the free radicals observed at room temperature are generally not the primary ones produced by the ionizing irradiation, but are secondary free radicals produced by molecular motions after the primary event of ionization. (auth)

18105 PREPARATION OF LABELED CARBON FROM RADIOACTIVE CARBONIC ACID. A. D. Mikhailin and N. N. Postnikov. *Radiokhimiya*, 2: 246-8 (1960). (In Russian)

A method is suggested for preparing labeled carbon from radioactive carbonic acid. It is shown that the properties of carbon black prepared from carbonic acid and from acetylene are identical. (R.V.J.)

18106 EVALUATION OF METHODS OF PREPARING RADIUM-BERYLLIUM SOURCES. V. M. Permyakov. *Radiokhimiya*, 2: 255-8 (1960). (In Russian)

Five preparation methods were compared and evaluated. All the methods produced practically identical neutron fluxes for 1 g of Ra. Pouring and compressing methods are best from the point of personnel safety. (R.V.J.)

18107 SCINTILLATION TECHNIQUES FOR NATURAL RADIOCARBON COUNTING AND APPLICATIONS FOR DETERMINING THE ABSOLUTE AGE. I. E. Starik, Kh. A. Arslanov, and A. P. Zharkov. *Radiokhimiya*, 2: 259-60 (1960). (In Russian)

A method of preparing specimens for scintillation counting and the data obtained are described. Results from counting in ethylbenzene and benzene are tabulated. (R.V.J.)

18108 POSSIBILITIES FOR SENSITIZING AND DESENSITIZING ACTION OF ADDITIVES IN RADIATION CHEMISTRY AND RADIOBIOLOGY. REPORT II. EFFECTS OF PHOTODYNAMIC SENSITIZERS ON TUMOR FORMATION AND ACUTE LETHALITY OF X-IRRADIATED ANIMALS. Ruprecht Koch, O.-Albrecht Neumüller, and Gunther O. Schenck (Universität, Freiburg i. B. and Max-Planck-Institut für Kohlenforschung, Mulheim/Ruhr, Ger.). *Strahlentherapie*, 114: 508-24 (Apr. 1961). (In German)

Radiobiological experiments are performed on sensitization in radiation chemical reaction systems. The sensitizers used were, 1,2-benzopyrene, 3,4-benzopyrene, 9,10-dimethyl-1,2-benzanthracene, 20-methylcholanthrene, riboflavin-5-phosphate, hematoporphyrin, protoporphyrin, and fluorescein-Na, these substances being tested on rats and mice. The effects of x-ray whole body irradiation with and without sensitizer are studied by means of, LD 50, Fe⁵⁹-incorporation into hemoglobin, and behavior of reticulocytes. Besides, the tumour-rate and incubation time are determined following joint action of carcinogen and x-rays. No case of sensitization could, however, be found. (auth)

18109 THEORY OF MOLECULAR DISSOCIATION INDUCED BY NEUTRONS. I. DIATOMIC MOLECULES. Yu. S. Sayasov and G. K. Ivanov (Inst. of Chemical Physics, Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz., 40: 513-23(Feb. 1961). (In Russian)

A theory of dissociation of diatomic molecules is developed which is based on the Fermi pseudopotential method. It is assumed that the neutron energy is of the order of the dissociation energy and that during disintegration the molecule remains in the ground electron state. Simple final formulas for the cross sections of the processes can be obtained under these assumptions. (auth)

18110 IMPROVEMENTS IN AND RELATING TO CHLORINATED POLYMERS. Solomon Harris Pinner (to T. I. (Group Services), Ltd.). British Patent 865,378. Apr. 19, 1961.

A process is presented for manufacturing rigid or semi-rigid compositions based on polyvinyl chloride. The process comprises blending a mixture of polyvinyl chloride and a non-volatile polymerizable unsaturated monomer having a plasticizing effect on the polymer, molding the mixture, and irradiating the shaped product to convert the monomer into a polymeric form with a reduced plasticizing effect. In this way, the mobility of polyvinyl chloride at the molding temperature can be increased without increasing its softness at normal temperatures, and a monomer may be selected which has a protective effect against radiation discoloration and a cross-linking effect in addition to the plasticizing effect. Monomers and radiations suitable for use in the process are given, and various industrial applications of the process are suggested. Strength and solubility data are reported for several polyvinyl chloride compositions made using diallyl phthalate, diallyl sebacate, nonyl methacrylate, ethylene dimethacrylate, triallyl cyanurate, etc., as additives. (D.L.C.)

18111 HIGH TEMPERATURE HYDROCARBON RADIOLYSIS. Robert Byron Long, John Ploeger Longwell, and Henry Jacob Hibshman (to Esso Research and Engineering Co.). British Patent 866,752. Apr. 26, 1961.

A hydrocarbon (HC) cracking process is described that yields 80 to 99 mole % of low-molecular weight product containing one to three carbon atoms per molecule. The HC is heated to its incipient thermal cracking temperature at 1 to 16 atm, then irradiated by either fast neutrons, γ rays, or electrons with a minimum energy of 30 ev to a total energy absorption of 2.6×10^{15} to 5.2×10^{21} ev/g. The HC may be a petroleum oil, a petroleum naphtha, a petroleum gas oil, a petroleum residua, or other HC material that has a boiling point between 80 and 1300°F. (T.F.H.)

Raw Materials and Feed Materials

18112 (FMPC-400(Del.)) USE OF MONATOMIC HYDROGEN IN THE UF₆-UF₄ REDUCTION. R. M. Spenceley and F. M. Teetzel (National Lead Co. of Ohio, Cincinnati).

May 6, 1953. Decl. with deletions Mar. 2, 1960. Contract AT(30-1)-1156. 18p.

A description is given of the conception, design, procurement, installation, and operational results of the use of monatomic hydrogen in the UF₆-UF₄ reduction unit located in the pilot plant. (auth)

18113 (MCW-1429(Del.)) PROCESS DEVELOPMENT QUARTERLY REPORT. PART II. PILOT PLANT WORK. J. U. Shepardson and J. A. Nelson eds. (Mallinckrodt Chemical Works, St. Louis). May 1, 1959. Decl. with deletions May 13, 1960. 128p.

Work was continued on solvent clean-up, fluid-bed denitration, the preparation of micronized uranium compounds, on vacuum casting from dingot bombs, and on the gamma extrusion of dingot metal. Results are reported on the reduction of the nitric acid-insoluble uranium content of Vitro concentrates, on the improvement of TBP recovery from raffinate, on the direct conversion of uranyl nitrate liquor to UO₂, on attempts to reduce the beta-treated grain size of dingot uranium, and on the effect of cooling rate through the beta \rightarrow alpha transformation on the metallurgical structure of uranium. (auth)

18114 (NLCO-715(Del.)) SUMMARY TECHNICAL REPORT FOR THE PERIOD OCTOBER 1, 1957 TO DECEMBER 31, 1957. John W. Simmons, ed. (National Lead Co. of Ohio, Cincinnati). Decl. with deletions Feb. 3, 1960. Contract AT(30-1)-1156. 73p.

Evaluations were completed of seven feed materials for the Refinery. The changes in physical properties resulting from degradation of proposed kerosene diluents for the Refinery solvent were studied. Changes in the infrared and ultraviolet spectra of the diluents were examined. Ammonia treatment of uranyl nitrate solution prior to thermal decomposition results in significantly lower iron and nickel levels in the orange oxide but does not increase conversion of sulfated orange oxide to UF₄. The speed of reduction of orange oxide to UO₂ is not affected by particle size in the 1 to 100 μ range. The activity of pot-calcined orange oxide was found to vary significantly for successive batches. Significant differences were found in the hydrofluorination rates of UO₂ derived from two sources. UO₂ derived from "ammonium diuranate" was hydrofluorinated at high rates and should be amenable to processing with very small excesses of HF in a countercurrent process. A device for continuously detecting the HF concentration of a gaseous HF-H₂O mixture was fabricated and installed in a Green Salt Plant off-gas line. High-quality green salt (UF₄) is necessary for good reduction efficiency in the continuous reduction of uranium tetrafluoride to uranium metal with magnesium. Magnesia-alumina spinel shows promise as a refractory material for the reactor. Excellent slag-metal separation and an improved reduction yield were obtained when Domal magnesium was used as the reductant in the production of 13 twelve-inch-diameter uranium derbies. The decontamination factors experienced when UF₄ was reduced to derby metal and when derby metal was vacuum melted and cast are reported. Composite vacuum remelt charges, containing pigots produced by salt-melting briquettable chips, ingot drip crops, reduction scrap, and dingot turnings, were melted. The quality of the ingots obtained was comparable to that of normal production ingots. A chemical method of removing nickel cladding from uranium fuel elements was developed. Substantial savings in direct materials were obtained by recycling a percentage of the clarified acid filtrate. An ID gauge capable of testing a bore to a depth of 9 inches was developed. Its range at a given setting is ± 0.025 inch, and it is sensitive to a variation of 0.00015 inch. External dimensions of bare fuel

elements can be recorded automatically by means of a recording apparatus activated by differential air pressure. Procedures for the spectrographic analysis of twelve impurity elements in magnesium fluoride containing less than one per cent uranium are reported. Heating green salt at elevated temperatures did not adequately improve the stability of the material in the atmosphere. (auth)

18115 (NP-10110) MONTHLY REPORT [OF] DEVELOPMENT, MARCH 1961. (Eldorado Mining and Refining Ltd. Research and Development Div., [Ottawa]). 27p.

Beaverlodge. Data obtained in atmospheric carbonate leach tests on feed prepared from January mill head samples are given. The effects of dispersed air, CO_2 flow, and leaching conditions on extraction of U are discussed. The recycling technique was tested in the precipitation of diuranate by NaOH; a NaOH excess of 4.0 g/l produced barren solutions of U_3O_8 concentration ~ 0.05 g/l. A study was made of amalgam decomposition rates of U-free synthetic aqueous salt solutions and of scavenging U from barren solutions by amalgam reduction. The results indicate that high U recovery can be obtained without boiling. Port Hope, Refining. The de-emulsifying effects of Florida phosphate rock on the solvent extraction step were studied by measuring the time required for phase separation with and without the rock as additive. A concentrate made from Algom chemical precipitate, a plant feed material, was tested for Pa^{231} and found negative. Port Hope, Metal and Ceramic Oxide. The results of metallographic examination of accepted and rejected as-rolled NRX and NRU production rods are given. No correlation between structure and terminal rolling temperature was found. Photomicrographs of samples taken from various steps in the fabrication of 18M series NRX show that cold drawing results in a recrystallized structure. The results of metallographic and chemical analyses of heat-treated Fe-Al dilute alloys are given. Differential thermal analysis of mixtures of Mg with UO_2 , U_3O_8 , and UO_3 were made; exothermic reactions were observed at 600°C for all cases. Several ways for carrying out reduction of UO_2 and U_3O_8 by Al were tested, and the following optimum conditions were established: A mixture of U oxide, cryolite, and Al is held at 1400°C for 20 min and then cooled with dry ice. The amount of Al used should be six times the stoichiometric amount required for UO_2 and four times that for U_3O_8 , and the amount of cryolite should be such to give 16 wt.% Al_2O_3 -84 wt.% cryolite as the slag composition. A number of high-density 80% U-20% Al pellets were made by pressing. The products of the reaction of U_3O_8 with ferrosilicon at temperatures up to 1800°C in argon were analyzed and found to be a mixture of UO_2 , Si, Fe, and SiC. The nature of blemishes on the surface of sintered UO_2 pellets was investigated. Calcining was found to be an effective means of removing fluoride from UO_2 pellets to give a product containing less than 10 ppm fluoride. Weighing, Sampling, and Analysis. An accurate method for Al determination using an Al complex which is extracted is described. The constituents of the slag produced by Mg reduction of U_3O_8 were found to be MgU_2O_6 , U, Mg, and MgO. Volumetric methods for determination of sulfate, amine, and alkyl phosphoric acid are briefly described. (D.L.C.)

18116 (ORO-395) CHARACTERIZATION OF UO_2 POWDERS. First Quarterly Report, October 10, 1960 to January 10, 1961. James F. Carpenter and Carl W. Kuhlman (Mallinckrodt Nuclear Corp., Hematite, Mo.). Mar. 22, 1961. Contract AT-(40-1)-2699. 22p.

Fifty pounds each of twelve different types of uranium dioxide were produced. Physical testing of the UO_2 powders

is underway and the data are tabulated for bulk, tap, and Scott densities, and agglomerate (Fisher Sub-Sieve) size. Chemical characterization of the powder was started and results are shown for percent uranium, percent uranium dioxide, oxygen to uranium ratio, and a number of the chemical impurities. Ceramic performance studies were initiated. A series of pellets were prepared under the same conditions for eight of the different oxide types. (auth)

18117 (TID-10133(Del.)) SUMMARY TECHNICAL REPORT FOR THE PERIOD OCTOBER 1, 1952 TO DECEMBER 31, 1952. T. C. Runion and R. A. Widing (National Lead Co. of Ohio, Cincinnati). Feb. 1, 1953. Decl. with deletions Mar. 10, 1960. Contract AT(30-1)-1156. 69p.

A summary is presented of the activities concerning process control, plant assistance, and chemical and metallurgical developments necessary to maintain production at the Feed Materials Production Center (FMPC). The six-inch perforated plate pulsed extraction column was operated at throughputs of 411 lbs U/hr/sq ft, with uranium losses for Q-11 feeds less than 0.1%. Reduction of UF_6 on a pilot-plant scale was further improved. The method of producing contours on SRO slugs by centerless grinding was improved; various grinding wheels, coolants, and wheel dressings were investigated. Rolling schedules were established for the FMPC rolling mill. Preliminary design specifications were completed on a furnace to oxidize uranium turnings. (auth)

18118 (TID-10136(Del.)) SUMMARY TECHNICAL REPORT ON FEED MATERIALS FOR THE PERIOD JANUARY 1, 1953 TO MARCH 31, 1953. T. C. Runion (National Lead Co. of Ohio, Cincinnati). Apr. 15, 1953. Decl. with deletions June 14, 1960. Contract AT(30-1)-1156. 83p.

The outstanding chemical development activities during the period are summarized. The ability to digest and extract uranium satisfactorily from Blockson concentrates, Congo ion exchange concentrates, plant residues and other miscellaneous sources of feed materials was demonstrated on a laboratory scale. Serious deficiencies in plant equipment being installed for pumping and metering nitric acid slurry feeds were discovered as a result of Pilot Plant studies. The development of cracked ammonia instead of commercial hydrogen as a reductant for uranium hexafluoride in Pilot Plant studies will result in savings for the plant. The development of an atomic hydrogen generator for the hexafluoride reduction operation in preliminary studies appears capable of increasing throughputs in the hexafluoride plant by factors of two to three. Laboratory studies indicate that entrained solvent (TBP) should not cause foaming in the denitration of uranyl nitrate at the FMPC. Based on this development work, NLO has recommended the elimination of a proposed TBP stripper for the refinery. Development work resulted in a recommendation for the elimination of chlorides in the nitric acid recovery plant. Metallurgical development activities in laboratory and pilot plant operations resulted in increased efficiency and improved metal quality in rolling uranium for Hanford Works and Savannah River Operations. Cost for centerless grinding of slugs was decreased. Suitable physical testing and metallographic laboratories were developed for supporting uranium production and fabrication facilities at the FMPC. (auth)

18119 IMPROVEMENTS IN THE PREPARATION OF URANIUM HEXAFLUORIDE. Robert Abdon Gustison and Frank Wilson Hurd (to Union Carbide Corp.). British Patent 866,739. Apr. 26, 1961.

A process is described for producing high-purity UF_6 by extracting U from a 0.1 to 3.0 pH solution of ore concentrate and a complex-forming solution. The uranium com-

plex material is substantially insoluble in the aqueous acid solution. The complex in an organic diluent, which is inert to and immiscible with the aqueous acid solution, causes the U to concentrate with the complex. Hence a separation with concentrated HCl is accomplished by evaporating and then treating the remaining solution with ammonia to precipitate ammonium diuranate. The diuranate is dried and reduced to UO_2 with hydrogen gas. The dioxide is cooled in a non-oxidizing atmosphere and hydrofluorinated to UF_4 . The dried tetrafluoride is heated to remove water and is then reacted with fluorine gas to produce UF_6 which is distilled from the reaction mixture. (N.W.R.)

Separation Processes

18120 (AAEC/E-58) PURIFICATION OF CARBON DIOXIDE FOR REACTOR PURPOSES. PART I. LITERATURE SURVEY AND RECOMMENDED PROGRAMME. A. Draycott and A. C. Kerr (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Jan. 1960. Re-issued Feb. 1961. 13p.

The impurities likely to be present in CO_2 are listed; water is considered to be the most important in view of its adverse effect on the compatibility of many reactor materials with the gas. The literature on various desiccants is reviewed, and a suggested experimental program on drying the CO_2 is outlined. Other major impurities are O_2 and N_2 . Chemical means for continually removing the O_2 appear possible. It is likely that the N_2 content can only be lowered on charging the reactor; no continual method seems feasible at this stage. Minor impurities are mentioned, and the continual removal of dust in the coolant circuit is considered. (29 references). (auth)

18121 (CF-49-9-178(Del.)) FEASIBILITY REPORT ON RECOVERY OF FISSION Zr AND Cb FROM REDOX PROCESS WASTE SOLUTIONS USING SILICA GEL. (Oak Ridge National Lab., Tenn.). Sept. 28, 1949. Decl. with deletions Apr. 18, 1960. Contract W-7405-eng-26. 34p.

Ten column runs at high-activity level demonstrated the feasibility of the silica gel process for removal of fission Nb and Zr from the Redox Process waste solution 1AW. The process shows an 80 to 85% yield. Laboratory results indicate that the yield can be substantially increased by operation at higher temperature (e.g., 70°C) or at slower flow rates. (auth)

18122 (CF-58-12-50(Del.)) VOLATILITY PILOT PLANT: DESIGN OF HYDROFLUORINATOR FOR DISSOLUTION OF U-Zr FUEL ELEMENTS. S. Mann (Oak Ridge National Lab., Tenn.). Dec. 15, 1958. Decl. with deletions Mar. 19, 1960. 16p.

The hydrofluorinator is designed for the batch dissolution of metallic U-Zr fuel elements in a $NaF-ZrF_4$ or $NaF-LiF$ melt with HF . The vessel consists of a 5-in. ID, 9-ft high, dissolver tube holding two or three stacked fuel elements, and a superimposed deentrainment section 2 ft in diameter and 6-ft high. Internal instrumentation is limited to avoid dip lines that have proven troublesome in the fluorinator. (auth)

18123 (HW-20817(Del.)) RECOVERY OF PLUTONIUM FROM SLAG AND CRUCIBLE. C. Groot, H. H. Hopkins, Jr., and W. W. Schulz (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). June 15, 1951. Decl. with deletions Mar. 7, 1960. Contract W-31-109-Eng-52. 41p.

Slag and crucible can be dissolved satisfactorily by the Los Alamos method of total dissolution with nitric acid in the presence of aluminum nitrate. Extraction of 99% of the

plutonium from total dissolution salted with aluminum nitrate was achieved by three successive contactings with 1/10 volumes of 30% TBP-AMSCO 125-90W. The TBP-AMSCO phases contacted with leaching solutions salted with calcium nitrate must be scrubbed to remove calcium. Stripping with three 1/10 volumes of 0.1M hydroxylamine sulfate removes 99% of the plutonium from the 30% TBP-AMSCO, initially 0.1M HNO_3 . Plutonium(III) oxalate, (which could be blended into 234-5 operations) can be precipitated from the aqueous strip solution. It is chemically feasible to recycle slag and crucible solution to the Redox IIA column in amounts up to at least 10% of IIAF by volume. It is also chemically feasible to recycle nitric acid solution of slag crucible obtained in the presence of aluminum nitrate to the Product Precipitation step of the Second Decontamination Cycle of the Bismuth Phosphate Process. (auth)

18124 (HW-25615(Del.)) THE DETERMINATION OF U-237 AND FISSION-PRODUCT CONTAMINATION IN URANIUM RECOVERED BY THE REDOX PROCESS. M. B. Leboeuf (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 1, 1952. Decl. with deletions Mar. 23, 1960. Contract W-31-109-Eng-52. 15p.

The beta and gamma rays of U^{237} were investigated by absorption measurements and by γ -scintillation spectrometer measurements. Because it is isotopic with U^{238} , U^{237} accompanies the uranium recovered by the Redox Process, and its concentration is not diminished by the fission-product decontamination cycles. The fission-product beta tolerance was set at 30% of natural uranium and the gamma tolerance at 300%. Discussions are given of the measurements of the beta and gamma ratios, effects of absorbers and gamma measuring instruments on fission-product tolerance measurements, and the U^{237} level in the Redox UNH solution. (B.O.G.)

18125 (HW-67757) PROCESS SPECIFICATIONS FOR CHEMICAL HAZARD CONTROL-PUREX PLANT. R. G. Geier (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 6, 1961. Contract AT(45-1)-1350. 43p.

Purex process specifications related to chemical hazards control are presented. These specifications are a part of the basis for the flowsheets or are to be used in situations not covered by other instructions. (J.R.D.)

18126 (HW-68846(Del.)) PUREX PULSE COLUMN STUDIES-1960. G. Jansen and G. L. Richardson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Feb. 22, 1961. Contract AT(45-1)-1350. 26p.

A series of pilot plant runs was conducted to define new cartridges for increasing the capacity in the Purex 1 Bx, 2A, 1C and 2E columns and eliminate plastic cartridge failures in the HA column scrub section, the HS column and the 2A column. The most favorable designs are presented and data from the various runs are included. (J.R.D.)

18127 (KAPL-316(Del.)) THE 1A HYBRID FLOW-SHEET. B. V. Coplan, J. K. Davidson, W. O. Hass, and E. L. Zebroski (Knolls Atomic Power Lab., Schenectady, N. Y.). Apr. 14, 1950. Decl. with deletions Apr. 18, 1960. Contract W-31-109-eng-52. 40p.

A preliminary hybrid 1A flowsheet in which the extraction section operates substantially acid while the scrub section is acid deficient is presented. The effects of added nitric acid on the performance of the acid deficient 1A flowsheet are considered, and the need for control of the

entering stream acidities in such flowsheets is evaluated. Data on batch-countercurrent decontamination and plutonium recovery are included. (J.R.D.)

18128 (LS-93) LITERATURE SURVEY OF PYROMETALLURGICAL PURIFICATION OF METALS. 1. LIQUID METAL EXTRACTION. 2. PRECIPITATION IN MOLTEN METAL. M. Gazith (Israel. Atomic Energy Commission, Tel-Aviv). Jan. 1961. 20p.

Sixty-three references covering reports and published literature from 1945 to 1960 on the pyrometallurgical purification of metals are given. The following topics are covered: the Parks and related processes, precipitation in liquid metal, pyrometallurgical processing of nuclear fuel, extraction in the molten state, and precipitation from the molten state. An author index is included. (M.C.G.)

18129 (NYO-2524) FOAM SEPARATION IN ISOTOPE RECOVERY. Quarterly Report No. 3, January 1 to March 31, 1961. J. J. Weinstock and S. Mook (Radiation Applications Inc., Long Island City, N. Y.). Apr. 28, 1961. Contract AT(30-1)-2384. 13p.

A third group of foaming agents was tested for solubility, conductivity, foamability, and enrichment with Ce, Sr, and Cs. Additional information was collected with resin-surfactant systems for the removal of cesium from solution. Some new approaches to cesium removal using salicylate-surfactant systems were tried unsuccessfully. (auth)

18130 (ORNL-2770) PRODUCTION OF URANIUM METAL FROM UF_6 BY DIRECT REDUCTION WITH LITHIUM OR SODIUM AMALGAM. O. C. Dean (Oak Ridge National Lab., Tenn.). May 2, 1961. Contract W-7405-eng-26. 25p.

On a 3 to 16 g of uranium per batch scale, at 25 to 50°C, 86% of the UF_6 vapor carried in argon was reduced to UHG_4 by lithium amalgams containing 133 to 150% of the stoichiometric lithium requirement. The UHG_4 was decomposed in a vacuum retort to mercury and massive uranium metal. Two tentative flowsheets for continuous production of uranium metal by lithium amalgam reduction were proposed and demonstrated on a 10-g of uranium scale. In the sodium amalgam reduction of UF_6 , the maximum conversion to UHG_4 was 40%. The uranium amalgam produced in one run from the reduction of UF_6 by lithium amalgam was processed through all stages to recover 13 g of massive metal, representing 81% of the uranium in the original UF_6 . With the exception of mercury, the concentration of all impurities attributable to the method was lower than for electrolytic-grade metal. (auth)

18131 (ORNL-3022) MEASUREMENT OF HAZARDOUS COMPONENTS OF DAREX PROCESS OFF-GAS. T. A. Gens (Oak Ridge National Lab., Tenn.). May 1, 1961. Contract W-7405-Eng-26. 15p.

The hydrogen in the off-gas from batch Darex dissolutions of 304L stainless steel in refluxing nitric-hydrochloric acid mixtures where the hydrogen ion concentration was constant at 7 M (20 cc of acid per gram of stainless steel) increased from about 0.15 vol % in 2 M HCl to 2 vol % in 6 M HCl. In 2 and 3 M HCl the hydrogen concentration was maximum, 0.35 to 0.5 vol %, when 30 to 50% of the total dissolving time had elapsed. In 6 M HCl the hydrogen concentration remained in the 1.5 to 3.5 vol % range throughout the dissolution. The maximum nitrous oxide content of the off-gas increased from 0.7 to 10 vol % as the hydrochloric acid concentration was increased from 2 to 6 M. With a smaller volume of 5 M HNO_3 -2 M HCl the hydrogen content of the off-gas decreased and the nitrous oxide content increased. (auth)

18132 (PAN-191/IV) ALKYL SULPHOXIDES AS SOLVENTS FOR THE EXTRACTION OF MINERAL ACIDS AND URANYL NITRATE. (Ekstrakcja Azotanu Uranylu I Kwasow Mineralnych Sulfotlenkami Alkilowymi). W. Korpak (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Nov. 1960. 25p.

The results of research on the use of a new group of organic solvents, alkyl sulfoxides, are discussed. Solutions of sulfoxides in organic diluents (CCl_4 , o,m,p-xylene) extract uranyl nitrate from solutions of nitric acid or inextractable nitrates. Di-n-octyl sulfoxide (ST-88) extracts nitric acid well, perchloric acid less so, and hydrochloric (up to 4 M HCl) and sulfuric acid not at all; this makes extractive separation of these acids possible. As a solvent for uranyl nitrate, ST-88 was found to be notably inferior to trioctylphosphine oxide, and somewhat superior to tributyl phosphate. A rapid method was developed for determination of sulfoxides in solutions of diluents not extracting nitric acid. ST-88 was found to antagonize extraction with dodecylphosphoric acid (DDPA) of uranium from sulfuric acid solutions. Mixtures of trioctylamine and DDPA were found to be antagonistic systems. (auth)

18133 (TID-11850) RETREATMENT OF SPENT FUELS. Progress Report No. 2, 3rd Quarter, 1960. (Brussels. Centre d'Étude de l'Énergie Nucléaire. [1960]. AEC 95/Euratom 123. 205p. (Includes original, 128p.).

Chlorination. The reactions of uranium carbide with carbonic anhydride and carbon dioxide were studied under different conditions. The effect of oxido-reduction cycles on the reactivity of sintered oxide was investigated by a thermogravimetric study; reactivity variations and formation of U_3O_7 at a low temperature were found. The thermogravimetric study of reaction of CCl_4 and UO_2 is difficult due to volatilization of UCl_4 . Kinetics. The kinetics of sintered UO_2 oxidation and U_3O_8 reduction were studied. Various methods of determining particle sizes are compared with respect to radioactive materials. Technology of Powders. A systematic study of fluidization was made. Information was obtained on pressure drop, bed height, screen analysis, rigid obstacles, dead angles of fluidization, temperature distribution, powder rheology, and vacuum fraction. Different methods of heating gases in fluidized bed were tested, and the behavior of the base and dust extracting filters was studied. Various corrosion phenomena were observed and steps taken to avoid them. The systems of heating, thermostatisation, automation of dust extraction, and powder sampling were perfected. Equipment for production of UF_6 are discussed. Technology of UF_6 . Construction of the distillation column is discussed. An installation is being constructed for chromatography in the vapor zone. The merits of a spray tower versus a cyclone scrubber are discussed for removing fluoride impurities from laboratory air. Plutonium. A new thermobalance was designed. Equipment for fluorination and other functions is discussed. (D.L.C.)

18134 (TID-12665) EQUILIBRIUM EXTRACTION CHARACTERISTICS OF ALKYL AMINES AND NUCLEAR FUELS METALS IN NITRATE SYSTEMS. Summary Report, July 1, 1958 to July 1, 1960. V. C. A. Vaughen and E. A. Mason (Massachusetts Inst. of Tech., Cambridge). Oct. 1, 1960. For Oak Ridge National Lab. Contract W-7405-eng-26, Subcontract 1327. 230p.

Selected organo-nitrogen compounds in aliphatic and aromatic diluents were studied to determine their potential as solvent extraction agents for the aqueous reprocessing of irradiated nuclear fuels. Equilibrium extraction characteristics of important fission product elements were determined for aqueous solutions containing between about

2M and 10M nitric acid and up to 4M added sodium nitrate. The extraction agents studied were Aliquat 336, a quaternary ammonium compound, trilauryl amine, a tertiary amine, di(tridecyl) amine and Amine S-24, two secondary amines, and Primene JMT, a primary amine. These amines were dissolved in aliphatic Amsco Odorless Solvent or in toluene. The metals studied at MIT were Zr, Mo, Ru, Ce, Sm, and U. U distribution ratios were 0.01 to 1.0 for 0.3 M trilauryl amines. Nitrosyl ruthenium gave the highest distribution ratios of the fission products studied in acidic solutions ($E_A^0 \text{Ru} = 0.01$ to 0.1). Mo was quantitatively extracted from solutions less than 0.1 to 1.0 M nitric acid. Above 2M HNO_3 Mo, Zr, Ce, and Sm distribution ratios were below about 0.01. Salting with sodium nitrate, particularly at the lower acidities increased U, Ce, Ru and Sm distribution ratios. Primary and secondary amines gave low U distribution ratios. The ordering of the amines in increasing values of distribution ratios were generally primary less than secondary less than tertiary less than quaternary ammonium compound for U and the fission products. The potential usefulness of the organo-nitrogen compound was found to depend mainly on the distribution ratio of U, since the fission product distribution ratios did not greatly depend on organo-nitrogen or diluent type. The tertiary amine appeared to give the greatest intrinsic separation factors between actinides and fission products. However, the quaternary ammonium compound has not been eliminated as a possible extractant for this use. A brief summary of some of the published extraction characteristics of actinide elements with organo-nitrogen compounds is compared with similar published data for TBP and Dowex-2 extractions. The tertiary amine gives intrinsic separation factors of actinide elements and fission products superior to those obtained with Dowex-2. The tertiary amine gave separation factors for U and Ru approximately the same as those obtained with TBP, but gave separation factors higher than TBP for the other fission products studied. Tetravalent actinides were highly extracted by amines. (auth)

18135 (AAEC/Trans-5) INVESTIGATION ON COMPLEXING IN SOLUTION BY THE DISTRIBUTION METHOD. THE SYSTEM SELENOYL-2-ACETONE-Th(IV)- CHCl_3 - H_2O . V. M. Peshkova and A. P. Zozulya. Translated by H. J. de Bruin from Zhur. Anal. Khim., 14: 411-18(1959). 7p.

Selenoyl-2-acetone is more suitable for the extraction of thorium from aqueous solutions than acetylacetone which is extensively used for this purpose. The stability constants of thorium selenoyl-2-acetonates and the distribution coefficient of the extracted complex in the CHCl_3 - H_2O system have a higher value than those of thorium acetylacetonates. (auth)

18136 (CEA-tr-R-1032) PREPARATION DU XENON PUR. (Preparation of Pure Xenon). V. G. Fastovski, A. E. Rovinski, and Yu. (Iu.) V. Petrovski. Translated into French from Zhur. Priklad. Khim., 31: No. 1, 5-12(1958). 21p.

Separation of Xe from Kr by fractional distillation and adsorption was studied. The experiments show that adsorption should be done by a dynamic method at 233 to 213°K. Depending on the initial composition of the mixture, the adsorption should be 80 to 100 cm^3/g . One complete desorption of the adsorbed phase yields a product 70 to 80% Xe. For purer Xe, a fractional desorption by rapid preliminary pumping of the non-adsorbed phase in isothermal conditions to 223 to 233°K produces separations of 0.8 to 0.85. The adsorption procedure requires no pre-enrich-

ment (93% Kr and 7% Xe). It is suggested that in fractional distillation about 60 or 65% should be evaporated and the remainder sent to an adsorption apparatus. In this way an installation processing 3600 m^3 of O_2 per hr would produce 30 l/day with only 450 to 500 g adsorbent. (T.R.H.)

18137 (CEA-tr-R-1188) SEPARATION DES ISOTOPES RADIOACTIFS SUR UNE CATHODE AU MERCURE. III. ETUDE SUR LA SEPARATION DU CERIUM. (Separation of Radioisotopes on a Mercury Cathode. III. Study of the Separation of Cerium). V. P. Schvedov and Y-Bey Fou. Translated into French from Radiokhimiya, 2: 234-8(1960). 23p.

The optimum conditions for the separation of cerium on a lithium amalgam from acetate and citrate solutions of cerium were established. It was shown that for a Ce^{3+} concentration of 2.42×10^{-3} M, 99% of the Ce is separated in 70 min. (tr-auth)

18138 THE EXTRACTION OF BERYLLIUM AND ALUMINIUM FROM AQUEOUS SULPHATE SOLUTIONS WITH DI-(2-ETHYLHEXYL) PHOSPHORIC ACID. R. W. Catrall (Australian Mineral Development Labs., Parkside, S. A.). Australian J. Chem., 14: 163-6(Feb. 1961).

The experimental extraction equations are presented for the extraction of beryllium and aluminum from aqueous sulfate solutions with di-(2-ethylhexyl) phosphoric acid solution (EHPA) in kerosene. It is shown that under certain conditions beryllium can be separated from aluminum using this reagent. A structure is suggested for the beryllium complex. (auth)

18139 A STUDY ON ANION EXCHANGE AND AMINE EXTRACTION OF RARE EARTH ELEMENTS IN NITRIC ACID. Fujio Ichikawa (Japan Atomic Energy Research Inst., Tokyo). Bull. Chem. Soc. Japan, 34: 183-6(Feb. 1961). (In English)

The amine extraction of rare earth elements in nitric acid is compared with anion exchange and TBP extraction with respect to the increase or decrease in K_d value with increasing atomic number of rare earth elements. Concerning the relationship between distribution coefficient and atomic number of rare earth element, a similar trend is observed in anion exchange and amine extraction. The distribution coefficient decreases with increase in the atomic number. In TBP extraction, however, the corresponding value increases with increasing atomic number. It seems that the mechanism of amine extraction for rare earth element is similar to that of anion exchange. (auth)

18140 RADIOCHEMICAL STUDIES ON THE SOLVENT EXTRACTION OF INORGANIC IONS WITH DODECYLBENZENESULFONIC ACID. I. DODECYLBENZENESULFONIC ACID AS AN EXTRACTANT FOR INORGANIC IONS. Tomitaro Ishimori, Eiko Nakamura, and Hiroko Murakami (Japan Atomic Energy Research Inst., Tokyo). J. Atomic Energy Soc. Japan, 3: 193-9(Mar. 1961). (In Japanese)

The extraction behavior of some typical uni-, bi-, and tri-valent cations with dodecylbenzenesulfonic acid dissolved in 1:1 diethyl ether-ethyl acetate mixture from various solutions of mineral acids or acetic acid is studied radiochemically. The acid and solvent dependence of K_d values are determined and the characteristics of the solvent extraction with dodecylbenzenesulfonic acid are made clear. The acid dependence curves showed also dependence on the valency or ionic charge of the inorganic ion, while the solvent dependence curves for all cations gave slopes roughly equal to 2. The K_d values for anions are generally low. The results of acid dependence of cations toward dodecylbenzenesulfonic acid extraction may be useful in indicating the valency of the ion. (auth)

18141 THE ABSORPTION OF URANYL SULPHATE FROM 20% METHANOL BY AN ANION-EXCHANGE RESIN. D. E. B. Morgans and C. B. Monk (University Coll. of Wales, Aberystwyth). *J. Chem. Soc.*, 1819-20 (Apr. 1961).

The formulas of the uranyl sulfate complexes adsorbed from solution by anion-exchange resins are established as $\text{UO}_2(\text{SO}_4)_n^{(2-2n)}$ ($n = 1$ and/or 2). 20% methanol is used rather than water since it is somewhat better for promoting complex formation. The analytical results and relevant calculations are tabularly presented. (N.W.R.)

18142 CO-PRECIPITATION OF Am AND Eu WITH LANTHANUM OXALATES. V. I. Grebenshchikova and R. V. Bryzgalova. *Radiokhimiya*, 2: 152-8 (1960). (In Russian)

Co-precipitation of Am and Eu with lanthanum oxalate was studied in order to determine the mechanism of co-precipitation and the crystallization coefficients of the components. Co-precipitation of Eu results in co-crystallization, forming a mixed crystal. The crystallization coefficient, independent of acidity from 0.1 up to 1.5 N HNO_3 , is 3.8. The crystallization coefficient diminishes with increased oxalate ion concentration as a result of reduced Eu^{3+} concentration due to complexing with oxalate ions. The crystallization coefficients for Am ($D = 4.8$) and Eu ($D = 3.8$) indicate that separation by fractionating lanthanum oxalate crystals is impossible. (R.V.J.)

18143 PRECIPITATION OF Y(III) IONS WITH LANTHANUM OXALATE. V. I. Grebenshchikova and R. V. Bryzgalova. *Radiokhimiya*, 2: 159-63 (1960). (In Russian)

Precipitation of Y^{3+} with lanthanum oxalate forms mixed crystals. The crystallization coefficient does not depend on acidity from 0.1 to 1.5 N HNO_3 and is equal to 3.7. The crystallization coefficient decreases with increased oxalate ion as a result of Y^{3+} complexing. A sharp decrease in the crystallization coefficient occurs with an increase of "free" oxalate. (R.V.J.)

18144 PRECIPITATION OF TRIVALENT CERIUM WITH URANIUM OXALATE. D. N. Bykhovskii and A. A. Grinberg. *Radiokhimiya*, 2: 164-74 (1960). (In Russian)

Regularities in Ce^{3+} capture by uranium oxalate during precipitation from saturated solutions and the dependence of the precipitation on oxalate ion concentration, Ce^{3+} concentration, and other admixtures indicate the difficulty in achieving equilibrium in the system. The mixed crystals are never in equilibrium with the solution. The principle peculiarity of the system is found in the contrast between the coefficient D and λ ($\lambda \gg D$). (R.V.J.)

18145 COMPLEXING OF URANYL-NITRATE WITH PHOSPHOR-ORGANIC COMPOUND. II. M. F. Pushlenkov, G. P. Nikitina, and V. G. Voden. *Radiokhimiya*, 2: 215-21 (1960). (In Russian)

The composition of extracted complex compounds of uranyl nitrate-*n*-butyl ether di-*n*-butyl phosphinic acid in CCl_4 is described by the general formula $\text{UO}_2(\text{NO}_3)_2 \cdot 2\text{T}$ ($\text{T} = \text{DBEP}$ and TBPO). The stability constants of $\text{UO}_2(\text{NO}_3)_2 \cdot 2\text{DBEP}$ and $\text{UO}_2(\text{NO}_3)_2 \cdot 2\text{BEDBP}$ are 6.03×10^2 and 2.95×10^4 respectively. A curve $\ln S = f[\text{NO}_3^-]_n$, $\mu[\text{H}^+]_n$, $[\text{T}]_0 = \text{const.}$, in the case of TBPO , results from the organic phase extraction of $\text{UO}_2\text{NO}_3\text{ClO}_4 \cdot 2\text{TBPO}$ and $\text{UO}_2(\text{ClO}_4)_2 \cdot 2\text{TBPO}$ in addition to $\text{UO}_2(\text{NO}_3)_2 \cdot 2\text{TBPO}$. (R.V.J.)

18146 INVESTIGATION OF THORIUM SEPARATION FROM VARIOUS ELEMENTS BY TRACER METHOD. I. EXTRACTION OF THORIUM PHENYLACETATE BY DIETHYL ETHER. URANYL ION COMPOUNDS WITH PHENYL ACETIC ACID. SEPARATION OF THORIUM

FROM URANIUM. I. A. Tserkovnitskaya and A. K. Charykov. *Radiokhimiya*, 2: 222-30 (1960). (In Russian)

Favorable results were achieved in extractions of thorium phenylacetate by carbon tetrachloride, chloroform, diethyl ether, benzene, toluol, butyl alcohol, methyl butylketone, and other organic solvents. Complete extraction by diethyl ether was obtained at pH 3 to 5 and ammonium chloride ionic strength of 2. Quantitative extraction of thorium from the organic phase is accomplished by re-extraction with dilute (1:10) mineral acids. The dissociation constant of the phenyl acetate is $(8.1 \pm 0.4) \times 10^{-5}$ and the distribution constant between diethyl ether and water is 34 ± 2 at 20° . A double uranyl and ammonium phenylacetate, $\text{UO}_2(\text{C}_6\text{H}_5\text{CH}_2\text{COO})_2 \cdot \text{C}_6\text{H}_5\text{CH}_2\text{COONH}_4$, was found, and a method was developed of separating thorium from larger quantities of uranium through the phenylacetate formation. (R.V.J.)

18147 SEPARATION OF RADIOISOTOPES ON MERCURY CATHODE. II. SEPARATION OF RARE EARTHS WITHOUT A STABLE DIVALENT STATE. V. P. Shvedov and I-pei Fu. *Radiokhimiya*, 2: 231-3 (1960). (In Russian)

The separation of trivalent rare earth metals in conditions interfering with hydroxide precipitation was studied. It was found that under certain conditions La, Ce, Nd, Pm, Y, Er, and Lu, which do not have stable divalent states, can be separated at a mercury cathode. It is postulated that electrolytic separation results from a reduction to the divalent state followed by an exchange with mercury amalgam. (R.V.J.)

18148 SEPARATION OF RADIOISOTOPES ON MERCURY CATHODE. III. SEPARATION OF CERIUM. V. P. Shvedov and I-pei Fu. *Radiokhimiya*, 2: 234-8 (1960). (In Russian)

Optimum conditions are found for Ce separation at a mercury cathode (electrodeposition on lithium amalgam) from cerium acetate-citrate solutions. It is shown that within ~10 min 99.0% of the Ce can be separated at a Ce^{3+} concentration of 2.42×10^{-3} M. (R.V.J.)

18149 ON THE PROBLEM OF THE EFFECTS OF MOLECULAR SIZE, COMPLEXING AGENT, AND TEMPERATURE ON ION EXCHANGE SEPARATION OF RADIOACTIVE RARE EARTH ELEMENTS. B. K. Preobrazhenskii, A. V. Kalyamin, and O. M. Lilova. *Radiokhimiya*, 2: 239-42 (1960). (In Russian)

Separation coefficients are determined for all rare earths and actinides separated by ammonium lactate. An optimum molecular size is found to be effective in the selective complexing of similar elements; the heavy rare earths submit to ammonium lactate separation easier than the light ones. The temperature effects ion exchange separation, complexing selectivity, and separation coefficients of neighboring elements. (R.V.J.)

18150 VERIFICATION OF INSTABILITY CONSTANTS FOR CERTAIN LANTHANIDES WITH ETHYLENEDIAMINETETRAACETIC ACID ANIONS. V. P. Shvedov and A. V. Stepanov. *Radiokhimiya*, 2: 261-2 (1960). (In Russian)

The instability constants for complex La, Ce, Pm, Eu, and Y compounds formed with ethylenediaminetetraacetic acid are verified. (R.V.J.)

18151 ON THE MECHANISM OF ZIRCONIUM NITRATE EXTRACTION BY TRI-N-BUTYL PHOSPHATE FROM HIGH ACIDITY SOLUTIONS. Z. N. Tsvetkova, A. S. Solovkin, N. S. Povitskii, and I. P. Davydov. *Zhur. Neorg. Khim.*, 6: 489-92 (1961). (In Russian)

Zirconium nitrate extraction from highly acid solutions

by TBP follows the reaction: $\text{Zr}^{4+} + 4\text{NO}_3^- + n(\text{HNO}_3)_m \cdot \text{TBP} \rightleftharpoons \text{Zr}(\text{NO}_3)_4 \cdot n(\text{HNO}_3)_m \cdot \text{TBP}$ and forms, in the organic phase, complex compounds $\text{Zr}(\text{NO}_3)_4 \cdot 4 \text{HNO}_3 \cdot \text{TBP}$ and $\text{Zr}(\text{NO}_3)_4 \cdot 2 (\text{HNO}_3)_2 \cdot \text{TBP}$. (R.V.J.)

18152 PROCESS FOR THE SEPARATION AND PURIFICATION OF ZIRCONIUM AND HAFNIUM. Kurt Peters. British Patent 866,719. Apr. 2, 1961.

A process for the separation and purification of hafnium and zirconium by means of complex compounds is described. The process consists of first treating freshly prepared

zirconium-hafnium phosphates or hydroxides with sufficient oxalic acid to achieve complete dissolution. Simultaneously or subsequently an equal amount of oxalic acid is added to complex the compounds until they cannot be decomposed by boiling or by addition of coagulants. The complex is then fractionally precipitated by adding mineral acid. The precipitant may be a hydrochloric acid-ammonium oxalate solution which contains phosphoric acid, a water soluble phosphate with a mineral acid, or phosphoric acid alone. (N.W.R.)

ENGINEERING AND EQUIPMENT

General and Miscellaneous

18153 (AD-247369) VARIPULSE X-RAY SYSTEM. A BIOLOGICAL X-RAY SYSTEM FOR USE IN ULTRAFRACTIONATED DOSE STUDIES. (Linfield Coll., McMinnville, Ore. Research Inst.). Sept. 1960. Contract DA-49-007-MD-934. 40p.

The equipment and operation of the Varipulse X-ray System are described. The system is designed specifically for ultrafractionated dose studies. The heart of the system is an x-ray triode tube which permits rapid on-off switching of the output. The bulk of the system comprises equipment for supplying the required high voltage and pulsed control voltages necessary to the operation of the triode. The output of the system is in pulses continuously variable in length from less than one microsecond to greater than one millisecond with the duty cycle independently and continuously variable to values greater than 50%. The x-ray triode may be operated at anode voltages up to 100 kv d-c at pulse currents up to 100 ma and average currents up to 5 ma. Thus, an extreme range of the critical variables, pulse length, and on to off time ratio, is available at useful x-ray levels for studies of the biological effects of ultrafractionated x-ray dose. (auth)

18154 (BNL-5437) LOAD TEST OF MACKWORTH G. REES 1000 MCM WATER COOLED CABLE. H. J. Thomas and W. W. Merkle (Brookhaven National Lab., Upton, N. Y.). Feb. 28, 1961. Contract AT(30-2)-Gen-16. 5p.

A test was conducted to observe the performance of the Mackworth G. Rees water-cooled 1000 MCM rubber covered cable with 700-v a-c insulation and maximum rated working pressure for the outer jacket of 80 PSI. Resulting data and calculations on pressures and temperature changes are given in addition to comparisons with a single-conductor neoprene-covered cable, and cost information. (J.R.D.)

18155 (INS-28) THE d.c. BIASED PULSE TRANSFORMER. Tetsuji Nishikawa, Hiroo Kumagai, Akira Miyahara, Jiro Tanaka, Kazuhiro Ishii, and Isao Ito (Tokyo Univ. Inst. for Nuclear Study). [1958]. 12p.

The superposition of a d-c bias field on an iron-core pulse transformer in the direction against the pulse magnetization is discussed. The d-c bias field was applied by using a bias coil connected to a d-c power supply through a choke coil and a condenser. The pulse characteristics of a core, with or without d-c bias field, were viewed in the synchroscope screen. Photographs of the pulse hysteresis curve of a typical core are given. The effective permeability of 10^3 to 10^4 for microsecond pulses could be obtained with the value of $\Delta B \approx 1.5$ webers/m². (M.C.G.)

18156 (NAA-SR-Memo-1533) DESIGN OF APPARATUS FOR IN-PLACE MEASUREMENT OF COEFFICIENT OF FRICTION IN A GAMMA FACILITY. K. E. Horton (North American Aviation, Inc., Downey, Calif.). Dec. 15, 1955. 13p.

An experimental apparatus is described wherein it would be possible to measure the coefficient of friction of a lubricant while under irradiation, at elevated temperatures, and at various bearing pressures. All measurements would be done continuously by electrical resistance means and recorded. (auth)

18157 (NP-10020) HOMOGENEOUS AEROSOL GENERATORS. Technical Report No. 13. K. T. Whitby, D. A.

Lundgren, and R. C. Jordan (Minnesota Univ., Minneapolis). Jan. 1961. 47p.

Two aerosol generators capable of generating essentially homogeneous, monodisperse, spherical, and electrically neutral solid particles of dye were developed. These are an atomizer-impactor combination theoretically capable of generating particles ranging in mass median size from 0.02 to 0.5 microns, and a spinning disk generator capable of generating particles from about 0.5 to 20 microns in size. Research during the development of the generators showed that under many conditions of operation the particles produced are electrically charged to a substantial fraction of the maximum equilibrium charge. The charge is neutralized by a unique ion generator which reduces the charge to a few percent of the maximum. The generators were developed using methylene blue in water or in ethyl alcohol. Because of the many advantages of fluorescent aerosols, an effort is being made to adapt the generators to make satisfactory fluorescent particles. Satisfactory particles are being generated from a mixture of methylene blue and commercial uranine dissolved in alcohol. The sensitivity of modern fluorescent measuring techniques is great enough so that the aerosol generators may be used to accurately evaluate gas cleaners at airflows of several thousand cubic feet per minute and efficiencies of 99.9% or greater. (auth)

18158 (SCR-291) GAGES REJECT TOO HIGH A PERCENTAGE OF GOOD PARTS. Edward S. Roth (Sandia Corp., Albuquerque, N. Mex.). Apr. 1961. 12p.

A discussion is given of solutions to the problem of gage rejection of in-tolerance products. Assembly relations are tabulated for parts and gages. A gage-fit allowance and tolerance table is given which should facilitate mating of product and gage. (B.O.G.)

18159 (TID-7604(p.69-72)) A SURVEY OF VARIOUS BLOWER SEALS. T. T. Frankenberg (American Electric Power Service Corp., New York).

A hot-water sealing problem associated with feed pumps is discussed. Numerous problems were associated with a seal on high-pressure pumps which depended on a floating sleeve of graphite impregnated with silver. One of the greatest difficulties was to parallel the low-pressure and high-pressure pumps. A modification of the original labyrinth seals resulted in excessive leakage and required considerable quantities of quenching water. A pump test rig and the instrumentation for it are described. (M.C.G.)

18160 (TID-7604(p.73-7)) A SURVEY OF VARIOUS BLOWER SEALS. F. G. Jensen (American Electric Power Service Corp., New York).

Various seal designs to be used in a feasibility study of a 50-Mw advanced gas cooled reactor are discussed. Four designs that are combinations of the basic seal components such as labyrinths, bushings, mechanical seals, oil buffer, and gas injection are described and diagrammed. (M.C.G.)

18161 (TID-7604(p.78-87)) RECIPROCATING COMPRESSOR SEAL EXPERIENCE AND PROBLEMS. D. M. Roberts and J. C. Hall (Babcock and Wilcox Co. [Atomic Energy Div., Lynchburg, Va.]).

A reciprocating compressor with its seals, which formed a part of the loop built to study a coolant composed of a suspension of finely divided graphite in gas, is described. In the early stages of system operation, some difficulty was experienced due to gas leakage through the shaft seal which consisted of 6 pairs of segmented Teflon

rings of the radial-tangent type. The apparent cause of the seal leakage and the effect of operation time on leak rate are discussed. To solve the graphite leakage problem, a buffer seal system was designed and installed on the system. A self-regulating gas supply was obtained for this seal by drawing the buffer seal gas supply through Fiberglass filters from a surge tank connected to the system at the compressor discharge. (M.C.G.)

18162 (TID-7604(p.141-6)) SEAL STUDIES AND INVESTIGATIONS. K. R. Stearns (Franklin Inst. Labs. for Research and Development, Philadelphia).

A face seal developed for a pressurized carbon dioxide loop intended for studies of flow maldistribution and mixing is described. An oil-lubricated face seal was chosen for sealing the shaft penetration. (M.C.G.)

18163 (TID-7604(p.147-56)) A PRECISION TESTER FOR STUDYING BASIC SHAFT SEAL PHENOMENA. H. C. Young (Oak Ridge National Lab., Tenn.).

A seal tester to be used for investigating the phenomena occurring in the area between the stationary and rotating seal faces of a shaft-type seal was designed. It was necessary to develop a method for providing precise support for the two seal test surfaces so that they could be held at closely controlled distances from each other and maintained in accurate alignment under a variety of operating conditions. Techniques were studied for measuring the seal gap to a tolerance of $\pm 3\mu$ in., the axial and radial runout of the rotating spindle, and the degree of parallelism between the stationary and rotating seal face during operation. (M.C.G.)

18164 (TID-7604(p.200-2)) SUMMARY OF DISCUSSIONS ON COMPRESSORS FOR AUXILIARY AND IN-PILE LOOP USE. W. F. Boudreau (Oak Ridge National Lab., Tenn.).

Compressor designs for auxiliary and in-pile loop use are discussed briefly. The different types of bearings, motors, and impellers and other portions of the aerodynamic assembly are discussed. (M.C.G.)

18165 (TID-7604(p.203-11)) EXPERIENCE WITH COMPRESSORS FOR IN-PILE GAS LOOPS. G. A. Francis (Battelle Memorial Inst., Columbus, Ohio).

In-pile loops developed for the Battelle Research Reactor (BRR) and the Engineering Test Reactor (ETR) are described. Design criteria for the BRR unit included 750°F inlet gas to the blower, a unit as compact as possible, a 10,000-hr life, and lubrication by conventional methods. A labyrinth seal was used to separate the clean circulating gas from a cask in which the blower and its auxiliary equipment were located. In the ETR loop design, auxiliary system cooling was needed because it was impossible to move the loop test section and the specimen in and out of the core. (M.C.G.)

18166 (TID-7604(p.227-31)) SPECIAL SEAL PROGRAMS. C. M. Allen (Battelle Memorial Inst., Columbus, Ohio).

The advantages of dry face seals over the liquid bushing seal were found to be such as to encourage continued research on dry face seals. Cermet and ceramic materials and, possibly, surface-treated refractory alloys showed the most promise for application to high-speed, dry, sliding-contact systems. The equipment and techniques developed for studying the phenomena that appear between the axial seal faces are described. The use of mercury as a fluid in seals is discussed. (M.C.G.)

18167 (TID-7604(p.231-5)) FLOATING-BUSHING SEALS. E. S. Dennison (General Dynamics Corp. Electric Boat Div., Groton, Conn.).

The characteristics of an acceptable floating-bushing seal are described. The question of water versus oil as the sealant or lubricant is reviewed. The possibility of the existence of a sort of escalator through the bushing by which gas actually climbs up against pressure, to appear on the high pressure side of the seal is discussed. (M.C.G.)

18168 (TID-12752) REMOTE-HANDLING EQUIPMENT CATALOG. C. L. Ridgeway (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Feb. 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 67p. (XDC-61-1-133)

A reference catalog of remote-handling equipment at the Idaho Test Station is presented. Equipment design descriptions are included for special purposes related to reactor power plant assemblies shielding, cores, instrumentation and control, turbomachinery, and auxiliary equipment. (J.R.D.)

18169 (Y-1347) LEAK RATE VERSUS ABSOLUTE PRESSURE STUDIES COMPLETION REPORT (PROJECT D-P-0131). Joseph H. Keith (Union Carbide Nuclear Co. Y-12 Plant, Oak Ridge, Tenn.). Jan. 16, 1961. Contract W-7405-eng-26. 13p.

An investigation was made to determine the possibility of leak testing a system at a low fill pressure but expressing the leak rate at a fill pressure of one atmosphere. Such a method would provide additional void volume for containing gases released by outgassing of the interior. By this method a leak rate range can be determined. The maximum and minimum of this range will be determined by the type of flow through the leak or leaks. In practice, the type of flow will not be known; therefore, the maximum of the determined leak rate range should be used. The leak rate as a function of pressure is discussed for both viscous and molecular type flow. (auth)

18170 (NP-tr-600) A STUDY OF DROP ENTRAINMENT IN A LABORATORY DISTILLATION COLUMN BY THE RADIOACTIVE TRACER METHOD. T. Lengyel. Translated by J. B. Sykes and M. Schiffer (U.K.A.E.A. Atomic Energy Research Establishment) from Magyar Kém. Lapja, 14: 314-17(1959). 16p.

Experiments were carried out to ascertain the entrainment in laboratory distillation apparatus using radioisotopes. It was found that, on the laboratory scale, only the drops entrained from the boiler flask need be considered; the dynamic hold-up liquid practically cannot be removed from the backing under customary distillation conditions. On examining the relation between the drop entrainment and the main properties of the vapor and liquid phases, it was found that the proposed correlation is valid on the laboratory scale. According to the experiments, the entrainment is of the order of 10^{-1} to $10^{-3}\%$, which, on the basis of Colburn's relation, has practically no influence on the separation efficiency. (auth)

18171 STRUCTURAL BEHAVIOUR OF A SPHERICAL PRESSURE VESSEL. D. S. Houghton and G. A. Ackroyd. Engineer, 211: 686-91(Apr. 28, 1961).

The strain distribution at the junction of a spherical reactor vessel and its supporting skirt is investigated using electrical resistance strain gauges with "Perspex" models. The experimental results are verified theoretically for several structural configurations, including a spherical reactor vessel having an outer cylindrical skirt only; and a spherical reactor vessel having both inner and outer cylindrical skirts. Throughout the investigation it is assumed that no axial loading exists in the skirt structure and that the loading is appropriate to a reactor vessel under uniform radial pressure. (auth)

18172 THE PHASE CONTROL OF ROTORS AT HIGH SPINNING SPEEDS. P. A. Egelstaff (U.K.A.E.A. Harwell, Berks, Eng.), H. J. Hay, G. Holt, J. F. Raffle, and J. R. Pickles. *J. Brit. Nuclear Energy Conf.*, 6: 71-8 (Apr. 1961).

A complex motor (called the spinning head) is described which can drive 20 lb rotors at speeds up to 60,000 rpm and at the same time allow the phase relative to another unit or a standard to be controlled. The system has a natural stability of 0.5° , and with a simple servo system, phase control to 0.1° is possible. The unit was developed for neutron spectrometer work and its value in this field is discussed. A number of spinning heads are in use in several neutron spectrometers and are shown to be very reliable in operation. (auth)

18173 CERTAIN DETAILS CONCERNING THE EQUIPMENT OF GLOVE BOXES. N. N. Khvostov (Central Scientific-Research Laboratory of Sanitation and Epidemiology, Ministry of Transportation, USSR). *Med. Radiol.*, 6: No. 1, 68-71 (Jan. 1961). (In Russian)

Bearing in mind the experiences in the operation of foreign laboratories, a special design of devices for changing the oversleeve gloves and for the removal of active samples without disturbing the hermeticity of the box is given. (auth)

18174 ABOUT THE KINETICS OF PUMPING OF THE VACUUM SYSTEMS IN QUASISTATIONARY REGIME. V. A. Malyshev (Malishev) (Taganrog Radiotechnical Inst.). *Zhur. Tekh. Fiz.*, 31: 200-3 (Feb. 1961). (In Russian)

Pressure distribution problems in pumped vacuum systems are analyzed, considering the reverse flow in the pump. Practical suggestions are given for determining pumping parameters. (tr-auth)

18175 IMPROVEMENTS RELATING TO PIPE COUPLINGS. Donald Stanley Pettinger (to A.E.I.-John Thompson Nuclear Energy Co., Ltd.). British Patent 866,230. Apr. 26, 1961.

A method is presented for easily forming a gastight coupling between a pair of tubular pipe members. The pipe ends are formed so that one end forms a sleeve around the other. Two or more annular grooves on the inside face of the sleeve are filled with a soldering or brazing compound. The pipe ends are telescoped together, and the soldering or brazing compound is melted to form a gastight seal. It is noted that this method may be used for the extensive piping of a reactor burst slug detection system. (T.F.H.)

18176 IMPROVED ARRANGEMENTS FOR HANDLING RADIOACTIVE MATERIALS. Victor Boris Hessen (to Pye, Ltd.). British Patent 866,515. Apr. 26, 1961.

A chamber for handling radioactive material is described. The chamber is provided with a television camera mounted inside the enclosure and the chamber is so arranged that the camera may be moved in any direction by remote control. By using this camera, windows are not needed for observing the radioactive handling with mechanical manipulators. If the camera fails, a periscope is provided. The chamber is marked whereby an operator can readily identify a particular part of the chamber reproduced by the camera. (N.W.R.)

18177 IMPROVEMENTS IN OR RELATING TO REMOVABLE SEALING DEVICES FOR SEALING AN APERTURE IN A PRESSURE VESSEL. Jack Hamm and George Oliver Jackson (to United Kingdom Atomic Energy Authority). British Patent 867,127. May 3, 1961.

A seal designed for the refueling apertures in the pres-

sure vessel of a gas-cooled reactor is described. The seal consists of a sealing member thrust structure and a series of struts acting between the structure and the sealing region of the member. At least one of the struts is extensible to create a thrust and means for distributing the thrust from any extensible strut to others in the series. The distribution of thrust is accomplished through rocking members alternately inverted on their arch. The ring of rocking members is capable of rocking on the struts and sealing members. (N.W.R.)

18178 IMPROVEMENTS IN OR RELATING TO SHIPPING CASKS FOR TRANSPORTING RADIOACTIVE MATERIALS. (to Edlow Lead Co.). British Patent 867,267. May 3, 1961.

An improved shipping cask for transporting radioactive material, which has the property of good heat conduction between the inside and outside of the cask, is described. The cask consists of an inner container having a cylindrical wall, a concentric outer casing, and a radiation-shielding material disposed between the container and the casing. The shielding material is a monolithic cast-lead mass. The cask is characterized by provisions for a plurality of heat conducting elements attached to the outer casing and extending into the cast-lead mass. (N.W.R.)

18179 IMPROVEMENTS IN OR RELATING TO REMOTE-HANDLING MANIPULATORS FOR RADIOACTIVE SUBSTANCES. Arthur James Howarth, Fred Jones, and Gordon Wortley (to United Kingdom Atomic Energy Authority). British Patent 867,297. May 3, 1961.

A relatively simple and inexpensive remote-handling manipulator, which is suitable for use with shielding walls of lead or other materials exceeding 4 inches in thickness, is described. The manipulator is comprised of a cubicle having shielding walls, a carriage movable on rails in an elevated narrow horizontal slot in one of the shielding walls, a framework mounted on the carriage so as to allow movement transverse to the carriage movement, and handling equipment supported by the framework. The handling equipment is operated by a "Bowden" cable controlled by means outside the cubicle. The handling equipment is also attached to a vertically disposed framework that is also operated from outside the cubicle. Releasable braking is used to hold the carriage and the framework in any desired position. A supply trolley may be fixed to the roof of the cubicle and linked to the carriage so as to follow the movement of the carriage. Substances for treatment and examination may be moved along the length of the cubicle by a rail system. (N.W.R.)

Heat Transfer and Fluid Flow

18180 (ANL-6313) MIXING OF A COLD LIQUID JET WITH A BOILING LIQUID STREAM. S. G. Bankoff (Ramo-Wooldridge. Div. of Thompson Ramo Wooldridge Inc., Canoga Park, Calif.). Oct. 21, 1960. For Argonne National Lab. Contract W-31-109-eng-38, Subcontract 31-109-38-1159. 18p.

The turbulent mixing of a cold liquid jet with a stream of vapor bubbles and saturated liquid is analyzed for a single axial liquid jet. The cases where the issuing jet velocity is very much greater than and nearly equal to the free stream velocity are considered. Transport of axial momentum and of scalar quantities in the stream are calculated and the results applied to the transport of enthalpy in a bubbly mixture. (D.L.C.)

18181 (ARC-CP-158) THE THERMODYNAMICS OF FRICTIONAL RESISTED ADIABATIC FLOW OF GASES

THROUGH DUCTS OF CONSTANT AND VARYING CROSS SECTION. W. R. Thomson (Gt. Brit. Aeronautical Research Council). 1954. 44p. (R-119).

An analytical study dealing with the adiabatic flow of gases with frictional losses through ducts of constant and varying cross section is presented. The thermodynamic treatment is essentially one-dimensional in character in that frictional effects are assumed to be uniformly distributed over the total cross sectional area of flow. With this simplifying assumption, relationships are deduced connecting the pressure, temperature, velocity and flow area of the gas at any one plane with those at any other plane in a duct. The main relationships are unusable for quantitative estimation except through graphs and the main value of the report lies in the presentation of these graphs, the use of which should facilitate the solution of duct flow problems. (auth)

18182 (CF-61-3-29) SLURRY MOCKUP RUN SM-10. P. H. Harley and L. F. Parsly (Oak Ridge National Lab., Tenn.). Mar. 13, 1961. 29p.

Run SM-10, an experiment to demonstrate the feasibility of pumping thorium slurries through the complex apparatus required in a slurry core or blanket for a thermal breeder reactor, successfully showed the operability of such equipment, which included a high- and a low-pressure system. The 300 SM-loop in which the slurry was circulated simulates the slurry core or blanket of a 5-Mw reactor. During this 1962-hr run, 2.0 to 2.4-density slurry was pumped to the high-pressure system, raising the thorium concentration to >950 g/liter each time. Slurry was circulated in the high-pressure system at 1500 psi and temperatures up to 300°C. Flow characteristics and slurry heat-transfer coefficients were obtained on an 18-parallel-tube heat exchanger located in a horizontal position. No plugging or local erosion was observed during the run or following a six-day downtime. During the run it was demonstrated that the low-pressure system reliably supplied slurry for feed and contained the charge during emergency dumps from the high-pressure system. Valves with aluminum oxide trim in the feed line and a valve with tungsten carbide trim in the letdown line contributed greatly to the successful operation. Equipment failures were limited to the radial bearings in the circulating pump, which ended the run, to the Zirca-lox-2 and 17-4 PH stainless steel trim of a letdown valve, and to the 17-4 PH stainless steel trim of the dump valve, following three dumps. (auth)

18183 (DPST-60-284) ROUGHENING OF HEAT TRANSFER SURFACES AS A METHOD OF INCREASING HEAT FLUX AT BURNOUT. W. S. Durant and S. Mirshak (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). 1959. 15p.

The burnout heat flux and friction factors for rough surfaces were measured for vertical tubes cooled by downward flow of water. An increase in the burnout heat flux of as much as 100% over a smooth surface was obtained at the same coolant velocity, temperature, and pressure. A net gain of as much as 80% in heat flux at burnout is possible if the coolant channel is widened to permit the same flow at the same pumping requirements as a smooth surface. The results of 50 experiments were correlated empirically, and may be expressed by an equation. (auth)

18184 (NASA-TN-D-594) AN ANALYTICAL AND EXPERIMENTAL STUDY OF THE THERMAL BOUNDARY LAYER AND EBULLITION CYCLE IN NUCLEATE BOILING. Yih-Yun Hsu and Robert W. Graham (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). May 1961. 43p.

High-speed motion pictures were made of schlieren and shadowgraph images of the nucleate boiling process in a small pool boiler. The pictures clearly showed the agitation around the bubbles and the behavior of the thin thermal layer adjacent to the wall during the ebullition cycle of a bubble. During the breakaway of a bubble, the thermal layer is destroyed around the nucleation site, and a circle of disturbance propagates approximately 1 bubble diameter from the site. Recovery of the thermal layer requires an appreciable time period, which may be greater than the bubble growth period. A new analysis for predicting bubble growth rate is presented that does not depend on predetermined experimental constants. The waiting period, which is the time period between the departure of a bubble and the formation of a new bubble nucleus on the same site, is discussed. An analysis indicated that this waiting period is dependent on the surface cavity size and the bulk temperature of the fluid. More experimental information on the thermal layer is required if the waiting period is to be predicted. A model of the nucleate boiling is suggested that incorporates the experimental observations. This model is used to explain the heat-transfer behavior of a boiling fluid. (auth)

18185 (NDA-2131-7) TENTATIVE CALCULATION PROCEDURES FOR PRESSURE DROP AND VOLUMETRIC DENSITY IN TWO-PHASE FLOW. H. G. Elrod, Jr. (Nuclear Development Corp. of America, White Plains, N. Y.). Apr. 1, 1960. Contract AT(30-1)-2303. 18p.

Procedures are given for calculating the pressure drop and density of a turbulent flowing mixture of steam and water. Theoretical and experimental evidence supporting the procedures is discussed. (D.L.C.)

18186 (NDA-2131-12) BOILING SONGS AND ASSOCIATED MECHANICAL VIBRATIONS. H. Firstenberg (Nuclear Development Corp. of America, White Plains, N. Y.). June 30, 1960. Contract AT(30-1)-2303. 30p.

The study is based on observations made at installations where boiling songs and vibrations were noted during heat-transfer studies. The study was undertaken to define the regions in which the boiling phenomena occur. A description is given of the phenomena, as well as, the causes and occurrences of the boiling songs, and salient system parameters related to the occurrences. (B.O.G.)

18187 (ORNL-1777) FUSED SALT HEAT TRANSFER. PART II. FORCED CONVECTION HEAT TRANSFER IN CIRCULAR TUBES CONTAINING NaF-KF-LiF EUTECTIC. H. W. Hoffman and J. Lones (Oak Ridge National Lab., Tenn.). Feb. 16, 1955. Decl. Mar. 22, 1961. Contract W-7405-eng-26. 44p.

Heat transfer coefficients were determined for the eutectic mixture LiF-KF-NaF (Flinak) flowing in forced convection through circular tubes. Heat, electrically generated in the tube wall was transferred uniformly to the fluid during passage through small-diameter tubes of nickel, Inconel, and 316 stainless steel. The variables involved: Reynolds modulus (N_{Re}), 2300 to 9500; Prandtl modulus (N_{Pr}), 1.6 to 4.0; average fluid temperatures, 980 to 1370°F; and heat flux, 9,000 to 192,000 Btu/hr-ft². Forced-convection heat transfer with Flinak can be represented by the general correlation for heat transfer with ordinary fluids ($0.5 < N_{Pr} < 100$). The existence of an interfacial resistance in Flinak-Inconel systems was established and its composition determined. Preliminary measurements of thermal conductivity and thickness of film were made. The results verify the effect of the film on Flinak heat transfer in small-diameter Inconel tubes. Thermal entry lengths, determined from variations of local heat transfer coefficients

in the entrance of the heated section, were correlated with the Peclet modulus. (auth)

18188 (TID-7604(p.91-7)) **THEORETICAL ASPECTS OF BACK DIFFUSION.** H. L. Weissberg (Oak Ridge Gaseous Diffusion Plant, Tenn.).

A theoretical estimate was made of the rate of back diffusion of the vapor from a sealing liquid through the annular channel between a shaft and a concentric sleeve. The model considered consisted of two parallel planes which formed the walls of the flow passage. The effects of the convolutions associated with a labyrinth-type seal and of shaft rotation were taken into account in the correlation of experimental data by introducing "effective" channel dimensions for diffusion and for viscous flow. Numerical examples showed that the back-diffusion rate based on this model is easily made extremely small. The diffusion decreased sharply with increasing total flow and increasing values for pressure drop across the channel. (M.C.G.)

18189 (TID-7604(p.98-100)) **BACK-DIFFUSION STUDY AND EVALUATION.** F. F. Szczesny (Allis-Chalmers Mfg. Co., Milwaukee).

It was found that the driving force for back diffusion is a function of the gas concentration. The seal investigated incorporated a labyrinth seal which separated the main system helium from the inner-bushing-seal drain chamber which received a combined flow of buffering fluid plus system gas. It was found that at an increased flow of helium from the system to the drain chamber, the back diffusion was smaller. (M.C.G.)

18190 (TID-7604(p.101-3)) **PROPOSED BACK-DIFFUSION TEST PROGRAM.** E. F. Babelay (Oak Ridge Gaseous Diffusion Plant, Tenn.).

A test apparatus to measure the amount of back diffusion across a seal gland of the labyrinth or bushing type is described. The equipment consists of a rotating shaft and seal pressure chamber. The pressure chamber will contain the seals being tested. The effects of variables such as absolute pressure, temperature, physical geometry of the labyrinth seals, viscosity of the fluids, and the degree of eccentricity between the rotating shaft and the seals can be determined in this test. (M.C.G.)

18191 (TID-7604(p.215-27)) **BACK-DIFFUSION AND METALLURGICAL PROBLEMS.** W. H. Moore (Aerojet-General Corp., Azusa, Calif.).

The behavior of back-diffusion in a labyrinth is discussed. The oil creep problem including the effects of process gas flowing through the labyrinth, the possibility of centrifugal effects from shaft rotation, and an experiment proposed to see if gradients can be picked up across the labyrinth are described. The nature of the flow liquids along the staff, radioisotope tracer techniques, and the use of thermal gradients to establish concentration gradients are also discussed. The topic of floating bushing seals and back-diffusion through them is reviewed. The effects of contaminants on the reactor and associated components are outlined. (M.C.G.)

18192 (TID-11514) **FLOW PATTERNS OF TWO-PHASE FLOW—A SURVEY OF LITERATURE.** John H. Vohr (Columbia Univ., New York. Engineering Research Labs.). Dec. 15, 1960. Contract AT(30-3)-187. 59p. (CU-2-60-AEC-187-Ch.E)

A survey was made of the literature on flow patterns occurring in simultaneous gas-liquid flows through ducts. Descriptions of gas-liquid flow patterns and the terminology used in denoting them are presented. The experimental investigations from which the descriptions are taken are

surveyed. The relations between flow pattern and pressure drop in gas-liquid flows are discussed. Horizontal, vertical, and vertical boiling flows were investigated. (M.C.G.)

18193 (TID-12470) **[WATER FLOW IN TUBES].** 1st Quarterly Report. Report on the Work Carried out During the Months of April, May and June 1960. C. Foure (Société Nationale d'Étude et de Construction de Moteurs d'Aviation. Division Atomiques, Suresnes, France). Aug. 24, 1960. AEC 202/Euratom 86. 14p.

Discussions are given of work done on two-phase discharges with single vortex, water-steam separation, and thermal tests with single vortex freon and water. (B.O.G.)

18194 (TID-12475) **[WATER FLOW IN TUBES].** 2nd Quarterly Report. Report on the Work Carried out During the Months of July, August and September 1960. C. Foure (Société Nationale d'Étude et de Construction de Moteurs d'Aviation. Division Atomiques, Suresnes, France). Oct. 26, 1960. AEC 202/Euratom 86. 7p.

Discussions are given of work done on two-phase discharges with single vortex, water-steam separation, and thermal tests with single vortex freon and water. (B.O.G.)

18195 **THE TRANSITION FROM BUBBLE TO FILM BOILING [BURN-OUT].** L. Böswirth (Allgemeine Elektrizitäts-Gesellschaft, Solothurn, Switzerland). Atomkernenergie, 6: 93-8(Mar. 1961). (In German)

With the aid of the pulse pressure which the quickly emerging steam exerts on the steam-fluid interface, a graphic model for explaining the passage from bubble to film evaporation is given. Formulas for the critical heat flux are derived, and the influence of various parameters is discussed. The formulas are valid for all fluids and are, as far as this can be expected, in good accordance with test results. It is shown, in particular, that the law, discovered by Cichelli and Bonilla, for the pressure dependence of the critical heat flux of organic fluids can be proved from the formulas derived. With simplifying assumptions, a relationship is derived from which the pressure dependence of the critical heat flux can be calculated in advance to about one-third of the critical pressure. (auth)

18196 **THE DYNAMICS OF VAPOR BUBBLES IN NON-UNIFORM TEMPERATURE FIELDS.** Novak Zuber (Ramo-Woodbridge, Los Angeles). Intern. J. Heat Mass Transfer, 2: No. 1/2, 83-98(Mar. 1961). (In English). (RWD-RL-160)

The physical principles governing bubble growth in a superheated liquid were originally formulated by Bosnjakovic and Jakob. Using these principles, Fritz and Ende derived an approximate formula for the growth of a bubble in a uniformly superheated liquid. It is shown that the energy considerations in the Bosnjakovic-Jakob analysis enable one to calculate also the approximate rate of growth of a bubble on a heated surface in a liquid at saturation. One need only take into account the heat flux from the heated surface to the liquid. One can improve the agreement with experimental data by making corrections which have already been applied by other authors to bubbles in a uniformly superheated liquid. Experimental data for bubbles growing and collapsing in subcooled boiling can be approximated similarly by considering the growth and collapse process separately. The growth rate is given by the extended Bosnjakovic-Jakob analysis. As shown by Bankoff and Mikesell, the collapse rate can be predicted by the solution of Rayleigh's equation for an isothermal process. The growth and collapse process can be combined by matching them at the maximum bubble radius, thus giving a complete picture of the life history of bubbles formed in subcooled boiling. (auth)

18197 A MODEL FOR CORRELATING TWO-PHASE, STEAM-WATER, BURNOUT HEAT-TRANSFER FLUXES. H. S. Isbin, R. Vanderwater, H. Fauske, and S. Singh (Univ. of Minnesota, Minneapolis). *J. Heat Transfer*, 83: 149-57 (May 1961).

A simplified model for spray-annular flow in round tubes and rectangular channels and its use for the prediction of the maximum heat fluxes for steam-water flows is described. The data are for upward flow at 2000 psia for uniform and "hot-patch" heat fluxes. The model is successfully applied to both uniform and nonuniform or hot-patch heat-flux tests. Burnout flux versus flow rate data obtained for uniform heat flux for a given inlet subcooling are sufficient for the evaluation of the characteristic parameters needed in the burnout model. Comparisons of predicted and experimental values of the burnout heat flux are encouraging, including 2 to 1 hot-patch tests. Further, the predictions for the 1.3 to 1 hot-patch tests are in accord with the experimental data that the hot-patch effectiveness is approximately zero. (N.W.R.)

18198 IMPROVEMENTS IN TUBULOUS HEAT EXCHANGERS. Martin Charles Peters (to Babcock & Wilcox, Ltd.). British Patent 865,425. Apr. 19, 1961.

A tubular heat exchanger is designed in which the problems associated with passing the tubes through the pressure vessel are alleviated. In this exchanger, the heat exchange surfaces are comprised by at least one bank of tubes joined at their ends through tubulous parts with headers disposed outside the pressure vessel. The tubulous parts are passed severally through thermal sleeves associated with the vessel wall and are forked within the vessel to connect with separate tubes of the bank. (D.L.C.)

18199 IMPROVEMENTS IN POWER PLANT AND IN TUBULOUS BOILER UNITS FOR USE THEREIN. Martin Charles Peters (to Babcock & Wilcox, Ltd.). British Patent 865,426. Apr. 19, 1961.

A tubular heat exchanger is designed for use with a power plant using a gas-cooled reactor as the heat source. In this exchanger, two opposed tube banks within the pressure vessel form the heat exchange surfaces of two forced-flow, once-through boilers. The tube banks are divided into zones which perform different heat exchange functions and which consequently have different tube arrangements. (D.L.C.)

18200 IMPROVEMENTS IN HEAT EXCHANGE INSTALLATIONS. Andre Huet. British Patent 865,996. Apr. 26, 1961.

A heat exchange system is described that is composed of a plurality of separate units; each unit is composed of at least 2 vertical casing tubes through which the reactor coolant flows. One of the tubes contains high- and low-pressure superheaters, and the other contains the high- and low-pressure evaporators. The separation of water and steam at each pressure stage is effected outside the casing tubes, in a separate drum and/or steam and water separator. This separator can be common to several units of the heat exchanger. A steam and water separator may, moreover, be provided inside the evaporators in the casing tubes. (T.F.H.)

18201 IMPROVEMENTS RELATING TO HEAT EXCHANGERS. (to Compagnie Francaise Thomson-Houston). British Patent 866,117. Apr. 26, 1961.

A method is described for heat exchange with no calefaction between a liquid coolant and a hot body. The liquid may flow through a channel, in which case continuous or intermittent helical vanes impart a circular swirling motion to the liquid. The outward force on the liquid caused by the

circular motion creates a void in the center of the channel, into which the liquid may boil. Modifications of this basic principle are discussed. Applications of the device to cooling leading wing edges of aircraft, klystron collectors, thermal motors, and reactors are outlined. (T.F.H.)

18202 IMPROVEMENTS IN VAPOR GENERATING HEAT EXCHANGERS. Anthony James Taylor (to Babcock & Wilcox, Ltd.). British Patent 867,306. May 3, 1961.

A boiler, suitable for a nuclear power plant, is described. The boiler includes a cylindrical pressure vessel arranged to lie with its axis horizontal or substantially horizontal, a vapor and liquid separating drum disposed above the level of the pressure vessel, and upriser and downcomer pipes arranged respectively to conduct vapor and liquid mixtures. Disposed within the pressure vessel are heat exchange surfaces affording a vapor generating section formed of tubes arranged for internal flow of the heating fluid. At least one other section, in series with the vapor generating section, is disposed within the pressure vessel and arranged for external flow of the heating fluid. (N.W.R.)

18203 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS AND NUCLEAR FUEL ELEMENT CANS. Norman George Worley (to Babcock & Wilcox, Ltd.). British Patent 867,310. May 3, 1961.

An improved fuel element sheath design having longitudinal fins is described. The fins project beyond helically shaped heat exchange surfaces or ribs. Such fins are sometimes termed splitters and are designed in a helical shape in a direction opposite that of the heat exchange ribs. The design gives a more uniform temperature distribution and provides better cooling. (N.W.R.)

Instrumentation

18204 (AFMDC-TR-60-15) FEASIBILITY OF A RADIATION DETECTION SYSTEM FOR SPACE TRAVEL. (Lockheed Aircraft Corp., Sunnyvale, Calif.). July 1960. Contract AF29(600)-2049. 50p. (LMSD-703014; AD-241378)

Preliminary design criteria are presented for a system of instruments for measurement of the species, intensities, and energies of space radiation. (auth)

18205 (AFOSR-226) USE OF CATHODE RAY TUBES IN PULSE-HEIGHT SPECTROSCOPY. Technical Note. No. 4. P. Thieberger and I. Bergstrom (Sweden). Kingliga Vetenskapsakademien. Nobelinstitutet for Fysik, Stockholm). Dec. 10, 1960. Contract AF61(052)-118. 14p.

The possibility of using cathode-ray oscilloscopes for pulse-height analysis in gamma ray measurements was studied. Two ways of generating signals obtained when the beam of a cathode-ray tube CRT hits a certain part of its screen were used for single channel manual (one oscilloscope used) and automatic (two oscilloscopes used) analysis of pulse spectra from NaI-crystal detectors. The signals are obtained either by viewing the screen of a conventional CRT by means of a photomultiplier tube or by making use of a specially designed CRT provided with additional internal electrodes from which pulses may be directly derived. It is concluded that the equipment described is well suited for energy and intensity comparisons of gamma rays. It is shown that the energy linearity is good and that it is possible to record photo peaks corresponding to gamma-energies as low as about 5 kev. Compared to conventional set-ups the arrangement shows several advantages and no additional limitations are found. (auth)

18206 (ANL-5890) THE ARGONNE 60-IN. SCATTERING CHAMBER. J. L. Yntema and H. W. Ostrander (Argonne National Lab., Ill.). Apr. 1961. Contract W-31-109-eng-38. 78p.

The 60-in. scattering chamber used with the external beam of the Argonne 60-in. cyclotron is described. The scattering chamber permits operation over an angular range from 4° to 176° with an accuracy of ± 3 min. of arc. The geometrical factors involved in the measurement of cross sections are known to $\pm 0.1\%$ or better. The angular positions of the detectors, the target changer, and an absorber foil system in front of the detection units are operated by remote control so as to permit continuous operation of the cyclotron when these parameters are varied. It is possible to operate several detectors simultaneously; and in order to permit angular correlation studies, the angular position of one detector can be varied by remote control with respect to the other detector units. A summary of some of the experimental work performed with this instrument is given. (auth)

18207 (ANL-6222) CHARGED PARTICLE OPTICS OF MAGNETIC SECTOR SPECTROMETERS WITH $H = H_0 \alpha r^{-1}$ (z, r, ϕ CYLINDRICAL COORDINATES WITH THE z -AXIS THE OBJECT-IMAGE LINE). A. H. Jaffey, C. A. Mallmann, J. Suarez-Etchepare, and T. Suter (Argonne National Lab., Ill. and Argentina. Comisión Nacional de Energía Atómica, Buenos Aires). Nov. 1960. Contract W-31-109-eng-38. 271p.

The charged particle optics of symmetric and asymmetric spectrometers was developed, taking into account the effects of fringing fields. Formulas are given for: the image of point and extended sources, and their resolution and transmission. The suppression of ghost peaks arising from multiloop trajectories was studied. Methods and tables for the calculation of instruments are given. A comparison was made between various instruments already constructed, and some general considerations concerning the choice of design parameters are presented. The correction (for fringing field effects) of sector profiles of instruments already constructed was analyzed, and formulas are given which permit the calculation of modifications of the profiles necessary to insure good focusing with high transmission. Tables include: general trajectory functions; profile curves; and dispersion and transmission functions for symmetrical instruments. (auth)

18208 (AWRE-O-59/60) THE T4020 EXPERIMENTAL 8 mm RECEIVER. B. L. Elphick (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). Apr. 1961. 42p.

A description is given of a broad band superheterodyne receiver of high sensitivity, for Q-band microwaves, used for detecting thermal noises and gyro resonances in plasmas. The bandwidth is 20 Mc. (auth)

18209 (CEA-1799) DISPOSITIF D'ENREGISTREMENT POUR THERMOBALANCE DE MAC-BAIN. (Recording Device for a Mac-Bain Thermobalance). G. Antier (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Grenoble). 1961. 6p.

A description is given of a recording device for a McBain thermobalance. The apparatus consists of a special differential transformer, driven by an electromechanic system, and of two recopying potentiometers. The sensitivity is a few microns. The precision is greater than 10^{-4} . The measuring scale is 10-cm long. (auth)

18210 (CEA-1843) ENSEMBLE COMMUTATEUR ELECTRONIQUE POUR ENREGISTREMENT AUTOMA-

TIQUE D'IMPULSIONS. (Electronic Commutating Equipment for the Automatic Recording of Pulses). Pierre Garnaud (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1961. 21p.

The electronic selector allows the recording of six separate channels of pulses with only one automatic recorder type S.F.A.T. 57.3 B. The numbers of pulses issuing from different counters or photomultipliers during the operating time are recorded on a paper tape by one "Electrosumma 14 Olivetti" during the stop-time. (auth)

18211 (CEA-1844) DESCRIPTION D'UN DISPOSITIF CONVERTISSEUR "TEMPS-AMPLITUDE", SPECTROMETRIE DE NEUTRONS RAPIDES PAR TEMPS-DE-VOL. (Description of a "Time-Amplitude" Converter Device; Fast Neutron Spectroscopy by Time of Flight). Gérard Souchere (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1961. 36p.

A description is given of equipment consisting of a time-amplitude converter designed for fast neutron spectroscopy. The principle of the converter is the same as that used by M. Gorodetzky for the measurement of radioactive half lives. The intrinsic resolution, or width at half height, with the generator pulses is 1.2×10^{-10} seconds. Results are given concerning the scattering of 14-Mev neutrons by carbon. (auth)

18212 (CF-61-4-32) USE OF 4 π HIGH-PRESSURE IONIZATION CHAMBERS AS SECONDARY STANDARDS FOR CALIBRATION OF GAMMA-RAY SOURCES. R. W. Peele (Oak Ridge National Lab., Tenn.). Apr. 17, 1961. 37p.

Procedures used to standardize the strengths of a number of encapsulated gamma sources used to calibrate the sensitivity of Compton and pair scintillation gamma spectrometers designed to determine the spectrum of prompt gamma rays from fission of U^{235} are described. Calibration of the ion-chamber response vs. source intensity was accomplished using calibration data obtained by W. S. Lyon. Instrumental drifts as a function of time were compensated using the observed response to long-lived sources. Calibration of the absolute efficiency of the chamber for various radioactive isotopes was performed in a method, based on an approximate calculation of this efficiency from cross-section data, on a number of absolute source calibrations using coincidence techniques, and on the existing ion-chamber efficiency ratios determined by W. S. Lyon. Attention was given to detailed estimates of the accuracy of the procedures used. (auth)

18213 (CNI-40) ISPRA NUCLEAR ELECTRONICS TRANSISTOR SYSTEM: SCALERS. V. Mandl (Italy. Comitato Nazionale per le Ricerche Nucleari. Centro di Studi Nucleari, Ispra). Sept. 1960. 20p.

Two scalers, Model CT3 and Model CT5, are described. Model CT3 has seven decades; the first one is transistorized and the others have cold cathode counting tubes (dekatron). The over-all resolving time is of 1 μ sec and all the counts stored can be printed on an adding machine. Model CT5 has two dekatrons and a four digit mechanical register; its resolving time is 25 μ sec. (auth)

18214 (DOFL-TR-886) ELECTRONIC INSTRUMENTATION FOR PROJECT 6.2, OPERATION PLUMBBOB. J. C. Hoadley (Diamond Ordnance Fuze Labs., Washington, D. C.). Apr. 5, 1961. 47p.

Magnetic component measurements were made of the near magnetic field associated with a nuclear detonation. The instrumentation design consisted of signal pick-up loops, shielded signal lines, and a self-powered shielded

package containing a magnetic tape recorder and associated control circuits. The design and performance of the automatic, multichannel, wide-band magnetic tape recording system are described. (auth)

18215 (DPS-56) EXPERIMENTAL INVESTIGATION OF A MISS-DISTANCE INDICATOR USING RADIOACTIVE TECHNIQUES. Date of Test: April 1960. R. E. Hollis (Development and Proof Services, Aberdeen Proving Ground, Md.). Oct. 1960. 37p. (AD-245655)

The inverse square law relationship that holds for a radioactive point source, if flux intensity as a function of distance is measured, suggests the application of radioactive techniques to a scalar miss-distance indicator. An experiment was performed in which measurements of flux intensities in terms of count rates were taken at approximately 15- and 30-foot radial distances from the point source. It was found that scatter effects of gamma particles complicated the experiment and were by far the greatest source of error. Free-field experiments under dynamic test conditions are recommended if serious considerations are to be given to the application of radioactive techniques to miss-distance measuring devices. The radiobiological effect of nuclear particle emission should never be neglected when radioactivated projectiles are handled. It is shown that only some simple calculations are needed to determine which safety precautions are sufficient for safe handling of activated ammunition. Because of the high rate of fire, and the complex space geometry encountered in test firing evaluations for an antiaircraft weapon of the VIGILANTE type, the radioactive MDI is not recommended. For simpler test parameters it has good possibilities. (auth)

18216 (HW-67787) A PORTABLE DOSE RATE INSTRUMENT FOR MEASUREMENT OF NATURAL BACKGROUND RADIATION LEVELS. F. L. Rising (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 19, 1960. 9p.

An instrument of the ionization chamber type which is capable of measuring radiation dose rates down to and below those encountered in natural background was designed and constructed. It consists of a 40-liter ionization chamber coupled to a portable battery-powered electrometer. The chamber polarizing battery is a part of the chamber center electrode assembly and is located inside the chamber. (auth)

18217 (HW-SA-2129) AN INVESTIGATION OF THE PERLOW SPECTROMETER AND ITS EXPERIMENTAL APPLICATIONS IN THE FIELD OF FAST NEUTRON SPECTROSCOPY. John Stone Loomis, Jr. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). 1961. 149p.

Thesis submitted to the Univ. of Washington.

Results of calibration and testing of three Perlow spectrometers are presented. A review of the literature and an outline of neutron spectrographic detection philosophy are included. The tools and techniques of fast neutron physics calibrations at Hanford are described followed by a discussion of Perlow spectrometer theory and operation. Calibration and test results are also included. (J.R.D.)

18218 (NAA-SR-4537) DEVELOPMENT OF A RAPID-OPERATING PLUGGING METER. K. Davis (Atomic International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Aug. 1, 1959. Contract AT(11-1)-GEN-8. 17p.

An air-cooled plugging meter for rapid determination of sodium oxide concentration in liquid sodium was tested in an experimental system. Approximately 200 plugging tests

were performed, with results indicating good repeatability and a relatively fast operating time compared to other plugging meters. A typical operating time for making a determination with a system temperature of 725°F was 5 minutes. (auth)

18219 (NAS-NRC-Pub-871) SEMICONDUCTOR NUCLEAR PARTICLE DETECTORS. Proceedings of an Informal Conference, Asheville, N. C., September 28-30, 1960. J. W. T. Dabbs and F. J. Walter, eds. (National Research Council. Committee on Nuclear Science). 1961. 280p.

Nuclear Science Series Report No. 32.

Thirty-nine papers are included which were presented at the Conference on Semiconductor Nuclear Particle Detectors. The papers are arranged under the topical headings of mechanisms of operation, detector configurations, applications, particle energy loss, semiconductor surfaces, materials, detection of low-energy particles, detector and amplifier noise, edge protection and stability, transient response, and recipes for detector fabrication. An extensive bibliography is included. Of the 39 papers, separate abstracts have been prepared for 34; three were previously abstracted. (D.L.C.)

18220 (NAS-NRC-Pub-871(p.1-8)) PULSE FORMATION IN SEMICONDUCTOR DETECTORS. J. W. Mayer (Hughes Aircraft Co., Los Angeles, Calif.).

The operation of semiconductor junction detectors is discussed generally to illustrate the factors affecting their performance. The conditions necessary for fabrication of useful semiconductor particle detectors and spectrometers are high carrier mobilities, high electric fields, long carrier lifetimes, high effective resistivity material and/or low leakage currents, and non-injecting contacts. The p-n or surface barrier junctions on Ge or Si meet these conditions, and their behavior under reverse bias is illustrated. Energy gap effects are discussed. It is shown that the high-field region determines the sensitive volume of the detector. (D.L.C.)

18221 (NAS-NRC-Pub-871(p.9-18)) PROPERTIES OF SPACE CHARGE REGIONS. W. L. Brown (Bell Telephone Labs., Inc., Murray Hill, N. J.).

The space charge region of a p-n junction is discussed, and surface barrier diodes are briefly considered. An explanation is proposed for the apparent defect in pair collection in fission fragment counting with surface barrier devices. Currents originating in the semiconductor bulk are treated, and the effects of recombination centers and lifetime on the junction current are discussed. (D.L.C.)

18222 (NAS-NRC-Pub-871(p.19-27)) DIFFUSED JUNCTION DETECTORS. G. L. Miller (Brookhaven National Lab., Upton, N. Y.). (BNL-5054)

The advantages and disadvantages of diffused junction detectors are outlined. The most serious disadvantage, multiple peaking, is discussed in detail. The leakage current is shown to vary inversely with the detector capacity. The rise time was measured from fission fragments and found to be 10 nsec, as compared with the calculated value of 2 nsec. (D.L.C.)

18223 (NAS-NRC-Pub-871(p.28-34)) ENCAPSULATED DETECTORS. R. L. Williams (RCA Victor Co., Ltd. Research Labs., Montreal).

Some of the problems encountered in the fabrication of encapsulated p-type Si detectors are discussed. Modifications giving improved resolution are described. The surface dead layer thickness was determined to be 0.013 and

0.9 μ for 0.2 and 2 μ diffusion layer thicknesses, respectively. Saturation current measurements were made at various temperatures and the results are discussed. (D.L.C.)

18224 (NAS-NRC-Pub-871(p.35-42)) EXPERIMENTS WITH n-p JUNCTION DETECTORS. G. Amsel (Paris. Université. Ecole Normale Supérieure. Laboratoire de Physique).

Results are presented for experiments performed with gallium diffused junctions in n-type Si with resistivities of 35 to 120 ohm-cm. In resolution experiments, the pulse height spread or peak width was found to be independent of the particle energy but dependent on the nature of the particles (30 kev for protons and deuterons, 40 kev for alpha particles). Performance spectra are presented for detectors used in conjunction with $O^{16}(d,p)$, $C^{12}(d,p)$, $O^{16}(d,\alpha)$, and other reactions. (D.L.C.)

18225 (NAS-NRC-Pub-871(p.43-8)) SURFACE BARRIER DETECTORS. J. L. Blankenship (Oak Ridge National Lab., Tenn.).

Surface barrier diodes have the same carrier lifetime after fabrication as the ingot because no extreme heat is required. The dependence of reverse current on bias voltage was found to contain two components, one bias-independent and the other dependent on the square root of the bias. Performance spectra are presented for the detectors with alpha particles; the resolution is 17 kev. Some of the advantages and disadvantages of surface barrier diodes are discussed. (D.L.C.)

18226 (NAS-NRC-Pub-871(p.49-51)) CHARACTERISTICS OF SURFACE BARRIER DETECTORS. G. Dearnaley (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England).

The sensitive depth of surface barrier detectors was measured. It was found that, in high-resistivity Si and with barriers of thickness approaching that of the wafer, the barrier becomes deeper more rapidly than the simple theory predicts. The performance of Si detectors is described; the best resolution was ~23 kev for 5.4-Mev alphas. The effects of running a forward current through part of the detector on its performance with gammas and alphas are described. (D.L.C.)

18227 (NAS-NRC-Pub-871(p.52-6)) NIP STRUCTURES IN SILICON AS DETECTORS OF NUCLEAR RADIATION. L. Koch, J. Messier, and J. Valin (France. Commissariat à l'Energie Atomique. Centre d'Etudes Nucleaires, Saclay).

The properties of a detector crystal of high-resistivity Si bounded by n and p diffused regions (called NIP structure) were studied. The particles penetrate the crystal parallel to the plane of the junctions in contrast to conventional p-n junctions where the penetration occurs in a direction perpendicular to the junction. For alphas at 39.6 Mev, the resolution is 2%, and the pulse height is linear in the particle energy. For gammas at 277 kev, the energy resolution is ~8%. The ionization energy was determined to be 3.53 ± 0.07 and 3.55 ± 0.1 ev for 600- and 277-kev electrons, respectively. Some industrial solid state detectors made in 1960 in France are described. (D.L.C.)

18228 (NAS-NRC-Pub-871(p.57-60)) COSMIC RADIATION MEASUREMENT PROBLEMS. G. W. Crawford (School of Aviation Medicine, Brooks AFB, Tex.).

The composition of the inner and outer cosmic radiation

belts is surveyed, and the advantages of solid state ionization chambers for their detection and measurement are discussed. Possible telescopes for energy band measurements are described. The radiation to be measured can be selected by changing the bias voltage. The application of solid state detectors in biological radiation damage studies is also considered. (D.L.C.)

18229 (NAS-NRC-Pub-871(p.61-73)) SEMICONDUCTOR DETECTORS IN NUCLEAR PHYSICS. D. A. Bromley (Yale Univ., New Haven).

Junction detectors are compared with conventional detector types (photographic emulsion, scintillation counters, gas counters, and magnetic spectrometers), and their advantages and disadvantages with respect to each type are given. Some possible ways of improving junction detectors are discussed: thicker depletion layers, transmission junctions, larger junction areas, mosaics, pulse discrimination systems, stabilized characteristics, impregnation, dE/dx -E junctions, and internal amplification. The use of junction detectors as gamma detectors is discussed. Spectra are presented for $Al^{27}(p,\alpha)$ reaction, C^{12} bombardment of C, O^{16} bombardment of SiO, $C^{12}(C^{12},\alpha)$ reaction, and O^{16} - O^{16} elastic scattering. (D.L.C.)

18230 (NAS-NRC-Pub-871(p.74-85)) dE/dx -E SEMICONDUCTOR DETECTOR SYSTEMS. H. E. Wegner (Los Alamos Scientific Lab., N. Mex.).

The advantages of dE/dx -E detectors are discussed, and performance data are given for a gas dE/dx , p-n junction E system and a complete p-n junction (dE/dx and E) system and compared with a conventional NaI system. The performance data are for He^3 ions on C^{12} at 21 to 25 Mev. (D.L.C.)

18231 (NAS-NRC-Pub-871(p.86-90)) MEDICAL APPLICATIONS. G. L. Brownell (Massachusetts. General Hospital. Physics Research Lab., Boston).

Possible applications of semiconductor probes in medicine are discussed: detection of heavy particles, as in neutron capture reactions for brain tumor therapy, and of beta and gamma radiation, as in isotope visualization within the body. (D.L.C.)

18232 (NAS-NRC-Pub-871(p.91-4)) ENERGY LOSS OF MOVING CHARGED PARTICLES IN A VALENCE OR IONIC CRYSTAL. H. C. Schweinler (Oak Ridge National Lab., Tenn.).

The problem of a charged particle moving through a valence or ionic crystal is considered with the mechanism of energy transfer assumed to be excitation of electrons from the valence band to the conduction band. Calculations were carried out for two energy bands in the respective forms of an ellipsoid of revolution and a spherical shape. It was found that: (1) The process has a threshold, which is dependent on the energy-band structure. (2) The energy loss per pair is only slightly greater than the energy gap between valence and conduction bands. (3) The energy loss per unit length of path and per pair should depend on the direction of the motion with respect to the crystallographic axes. (4) Velocity rather than energy is the appropriate independent variable for describing the energy loss and number of electron-hole pairs formed. A graph is given illustrating the relationship between particle velocity and propagation vectors at threshold for a charged particle moving in a $\langle 100 \rangle$ direction in silicon. (D.L.C.)

18233 (NAS-NRC-Pub-871(p.95-8)) ENERGY REQUIRED FOR ELECTRON-HOLE PAIR FORMATION IN SILICON. A. G. Chynoweth (Bell Telephone Labs., Inc., Murray Hill, N. J.).

Work done on the energy required for electron-hole pair formation in Si by electrons and particles is reviewed, particularly Shockley's hypothesis of possible electron energy loss through phonon emission. It is calculated that an electron having an energy of about 20 phonon energies above the threshold energy of 2.3 eV has a 1:1 chance of producing an electron-hole pair or decaying to energies lower than the threshold energy by phonon emission. The threshold energy for electron-hole pair production by high-energy particles is calculated to be 3.5 eV. (D.L.C.)

18234 (NAS-NRC-Pub-871(p.99-110)) SEMICONDUCTOR SURFACE EFFECTS. H. Statz (Raytheon Co. Research Div., Waltham, Mass.).

Tamm and Shockley type surface states are discussed for ideal, clean surfaces, and a qualitative picture is developed for understanding the origin and nature of these surface states. For real surfaces covered with oxide films, states can exist in the interface between the semiconductor and oxide film and on the surface of the oxide film. The interface states are due to imperfections or impurity atoms in the interface, and their density depends on prior surface treatment, e.g., oxidation, water vapor, ozone, etc. Certain interface states in Ge and Si can be manipulated with charged condensers brought near the surface. The contribution of interface states to surface generation or recombination of electron-hole pairs is discussed, and the dependence of the surface recombination velocity on the Fermi level position at the surface is shown for Ge. Outer surface states, next considered, are due to adsorbed atoms on the surface and generally have greater densities than the interface states and thus determine the sign of the surface charge and the amount of bending of the energy bands. Since these surface states are relatively far from the semiconductor, a certain time is required for them to adjust to changed charge conditions. The various surface charge conditions and their effects on devices are discussed for n and p type semiconductors. For a p^+-n junction with applied reverse bias, a positive surface charge narrows the space-charge region and increases the average field strength near the surface, setting up a surface avalanche breakdown at low applied voltages, whereas a negative surface charge has the opposite effect. In the presence of an inversion layer, the current as a function of voltage does not saturate. The inversion layer conductance as a function of bias voltage is calculated for Ge, and theoretical diode characteristics are derived in which current varies logarithmically with voltage. The effects of adsorbed water vapor on inversion layers and decay of outer surface state charges after a large bias pulse are discussed. Sometimes mobile charges of two signs are induced by water vapor. (D.L.C.)

18235 (NAS-NRC-Pub-871(p.111-20)) SURFACE EFFECTS ON SILICON PARTICLE DETECTORS. T. M. Buck (Bell Telephone Labs., Inc., Murray Hill, N. J.).

Results are presented for surface studies on phosphorus-diffused p-type silicon detector diodes. Work on the effects of chemical treatment on the surface conductivity and recombination velocity of silicon is reviewed. The effects of atmosphere (dry O_2 , dry N_2 , and wet N_2) on silicon counters of resistance 100, 200, and 4000 ohm-cm were measured and plotted on reverse current vs reverse bias graphs. The results for the surface breakdown voltage and reverse current below breakdown are explained qualitatively in terms of existing theories of p-n junction surfaces. Stabilization of surface conditions and reverse characteristics are discussed. (D.L.C.)

18236 (NAS-NRC-Pub-871(p.121-7)) REMARKS ON PHOTOCONDUCTIVITY AND GOLD-DOPED SILICON. W. J. Beyen (Texas Instruments, Inc., Dallas).

Transient phenomena in semiconductors of considerable magnitude (large signal) and of time short compared to any characteristic time of semiconductors are considered. For an energetic particle incident on a semiconductor and producing a number of charge carriers, the electric field must be high enough to extract the charge carriers before they are trapped or recombined. The carrier transient time must also be short compared to the dielectric relaxation time of the semiconductor in order to prevent secondary photocurrents. Work with solid state ionization chambers prepared from gold-doped silicon is reviewed. It is concluded that space-charge limited currents should be avoided if the transient time is to be short compared to the relaxation time. Creation of ionization paths or "pipes" in the semiconductor by the incident particle is discussed. (D.L.C.)

18237 (NAS-NRC-Pub-871(p.128-35)) RADIATION-INDUCED DEFECTS IN SILICON. G. K. Wertheim (Bell Telephone Labs., Inc., Murray Hill, N. J.).

Work done on electron and neutron bombardment of Si and Ge is reviewed. The displacement processes are discussed for each of the radiations: gamma, electrons, neutrons, and charged particles. Radioinduced defects are mobile at room temperature and tend to associate with dislocations or chemical impurities. The properties of radioinduced defects are tabulated under the headings of energy levels, introduction rates, and carrier capture cross sections for Si and Ge. The probable effects of these defects on junction detectors are discussed; it is concluded that Ge devices may be destroyed through the effect of bombardment on carrier concentration, whereas Si devices tend to be destroyed through a charge carrier lifetime effect. (D.L.C.)

18238 (NAS-NRC-Pub-871(p.136-44)) THE ION DRIFT PROCESS. E. M. Pell (General Electric Co., Schenectady, N. Y.).

Ion drift can be used in the field of a p-n junction to produce wide intrinsic regions. The ion drift process is discussed with respect to lithium ions in boron-doped silicon. A procedure is given for preparing such ion-drift junctions, and the resulting lithium distributions are shown to be stable. The rate at which the intrinsic region widens is determined by measuring the junction capacitance, and the width of the junction can be varied by varying the voltage. The effect of oxygen is shown to be noncritical. Some of the parameters to be selected in making a good ion-drifted detector are discussed: resistivity, in-diffusion temperature, drift temperature, oxygen content, and carrier lifetime. The problem of dead-layer thickness and the time required for the ion drift process are briefly discussed. Finally, the possible advantages and disadvantages of ion-drifted detectors are outlined. (D.L.C.)

18239 (NAS-NRC-Pub-871(p.145-53)) PROPERTIES OF HEAVY ATOM SEMICONDUCTORS. W. W. Scanlon (Naval Ordnance Lab., White Oak, Md.).

The properties of PbS, PbSe, and PbTe are reviewed with respect to possible use as semiconductor materials. The reviewed properties include maximum limits of stability of the compounds, Hall effect and resistivity, mobility of electrons and holes, lifetime as a function of dislocation density, and optical absorption. Radiative recombination rates are calculated. (D.L.C.)

18240 (NAS-NRC-Pub-871(p.164-70)) **GaAs DIODES: THEIR FABRICATION AND APPLICATION.** R. H. Rediker (Massachusetts Inst. of Tech., Lexington. Lincoln Lab.).

The main limitation of GaAs as a p-n junction detector is its low lifetime; however, it has certain advantages over silicon. The current-voltage characteristics of a GaAs diode are given. In general, high-resistivity GaAs is available but not with high purity. InSb is also discussed; InSb p-n junction diodes exhibit a large reverse current which, however, can be reduced by a magnetic field. A discussion is presented in which the properties of AlSb, GaP, and InP are discussed. (D.L.C.)

18241 (NAS-NRC-Pub-871(p.171-6)) **MULTIPLICATION PROCESSES IN P-N JUNCTIONS.** A. G. Chynoweth (Bell Telephone Labs., Inc., Murray Hill, N. J.).

The mechanism of multiplication processes in a reverse biased p-n junction is described. The disadvantage of multiplication as a means of obtaining a gain of 10 or more in the amount of charge collected is that it is patchy over the junction area, resulting in poor energy resolution. The possible use of microplasma phenomena occurring close to breakdown is considered, and several ways of predetermining the microplasma site are discussed. A group discussion is presented in which the possible use and characteristics of pure Si cooled to 20°K, a Ge detector at 0.2 and 77°K, and a compensated Ge detector with a negative resistance are described. (D.L.C.)

18242 (NAS-NRC-Pub-871(p.177-81)) **SEMICONDUCTOR ELECTRON MULTIPLIER.** F. A. White (Knolls Atomic Power Lab., Schenectady, N. Y.).

Very small positive ion currents of very low energies can be measured by generating sufficient secondary electrons and then accelerating these secondaries through suitable slits into p-n junction devices. A magnetic multiplier is described in which a n-type gold-doped silicon slab structure serves both as a dynode and as a secondary electron multiplying surface. The performance of this magnetic multiplier for europium isotopic abundance determination with 3×10^{-20} g material is given. The possibility of making a multiple matrix multiplier is considered. (D.L.C.)

18243 (NAS-NRC-Pub-871(p.193-5)) **SEMICONDUCTOR X-RAY DETECTORS.** T. R. Kohler (Phillips Labs., Inc., Irvington-on-Hudson, N. Y.).

The use of semiconductor detectors for x-ray diffraction and fluorescence work is discussed. It appears that Si detectors are confined to a rather limited energy range, on the lower end limited by the noise and on the upper end by the transparency of Si to x rays. Other materials with higher stopping power and/or other modes of operation are considered. It is concluded that a noiseless internal amplification mechanism is urgently needed for semiconductor detectors. (D.L.C.)

18244 (NAS-NRC-Pub-871(p.196-201)) **FAST NEUTRON SPECTROSCOPY WITH DUAL DETECTORS.** T. A. Love and R. B. Murray (Oak Ridge National Lab., Tenn.).

A neutron dual detector is described comprising two Si slabs plated with gold and Li^6F on their inside surfaces. Neutrons are detected with the aid of the $\text{Li}^6(n,\alpha)\text{H}^3$ reaction, but the efficiency is very low, varying from 3×10^{-3} at thermal neutron energies to 10^{-6} at 2 Mev. Pulse height vs deposited energy relationships are linear. Side reactions of Si are considered. Other semiconductor materials which may be used as neutron detectors are discussed. (D.L.C.)

18245 (NAS-NRC-Pub-871(p.202-9)) **LEAKAGE, NOISE, GUARD RINGS AND RESOLUTION IN DETECTORS.** W. Hansen and F. S. Goulding (California. Univ., Berkeley. Lawrence Radiation Lab.).

Calculations of leakage current and noise are presented for a detector-amplifier combination in which the amplifier contains one integrator and one differentiator of equal time constants. It is shown that generation current in the depletion layer constitutes nearly all the bulk leakage. The ultimate noise performance of a detector-amplifier system is expressed in terms of the properties of the input tube and semiconductor. The use of a guard ring structure to eliminate surface noise is studied. The leakage current at high voltages obeys a \sqrt{V} law; departures from the \sqrt{V} law at low voltages are attributed to surface injection at the periphery of the central region. The measured leakage current correlates well with the noise of a detector-amplifier system. The impedance between the central area and guard ring is discussed. Data are presented on the beta and alpha resolution of these detectors. In a group discussion, determination of carrier lifetimes and the relationship between noise and leakage current are considered. (D.L.C.)

18246 (NAS-NRC-Pub-871(p.210-20)) **PREAMPLIFIER CONFIGURATIONS AND NOISE.** E. Fairstein (Tennlec, Inc., Oak Ridge, Tenn.).

Two preamplifier configurations commonly used (voltage-sensitive and charge-sensitive) are described and their relative merits discussed. Two methods for measuring the signal-to-noise (s/n) ratio are outlined. The optimization of the s/n ratio under the restriction of fixed amplifier bandwidth is discussed. Pulse shaping effects on the s/n ratio are treated. A group discussion is presented in which resolution and capacitance properties of the detector and amplifier are discussed. (D.L.C.)

18247 (NAS-NRC-Pub-871(p.221-5)) **PARAMETRIC AMPLIFICATION OF RADIATION DETECTOR SIGNALS.** R. L. Chase (Brookhaven National Lab., Upton, N. Y.).

The possibility of an ideal loss-free periodically varying capacitor giving a better signal-to-noise ratio than a conventional amplifier is considered. A useful real circuit can be developed by decoupling the detector from the high Q primary circuit. The figure of merit for the parametric amplifier is given by $(V_g/V_1)/(R_{np}/R_e)^{1/2}$ and is calculated to be 3.3 for a particular case. Since this figure of merit is rather small, it is doubtful whether a parametric amplifier has any real advantages over a conventional amplifier. (D.L.C.)

18248 (NAS-NRC-Pub-871(p.232-6)) **OXIDE EDGE PROTECTION.** W. M. Gibson (Bell Telephone Labs., Inc., Murray Hill, N. J.).

Methods of protecting the edges of p-n junctions with oxide layers are reviewed. One satisfactory method is growing the oxide over the silicon slab, removing a window in the oxide, and then diffusing phosphorus through the window. Preliminary results obtained with this method are described; measurable response to ambient conditions was observed only under conditions of >90% humidity and with strong reverse bias. Combination of oxide protection with a guard ring configuration is considered. A group discussion of stability problems is presented. (D.L.C.)

18249 (NAS-NRC-Pub-871(p.268-9)) **PAINT-ON PARTICLE DETECTORS (RECIPE NO. 2).** Paul F. Donovan (Bell Telephone Labs., Inc., Murray Hill, N. J.).

A procedure is presented for preparing phosphorus-diffused p junction counters. The procedure involves

preparing silicon wafers, painting one side of the wafer with a P_2O_5 solution, heating to 930°C and cooling to 200°C over a period of ≈ 3 hr, rinsing and drying, masking with Apiezon W wax, and making electric contacts. Diodes prepared in this way have forward and back resistances of 1 to 20 kilohms and 300 to 1000 megohms, respectively, and a breakdown of >400 volts. (D.L.C.)

18250 (NAS-NRC-Pub-871 (p.270-2)) PROCEDURE FOR dE/dx SILICON SURFACE-BARRIER DIODES. R. J. Fox (Oak Ridge National Lab., Tenn.).

A procedure is presented for fabricating silicon surface-barrier detectors with alpha particle resolution better than 22 kev. The dimensions of the detector wafers are 0.5 cm^2 area and 0.2 mm thickness. In the procedure, thin silicon wafers are prepared, cemented in clusters of three, etched, and mounted in ceramic mounting rings. Electrical contact is made by gold-plating both sides of the silicon and ceramic ring. A representative energy spectrum measured with a detector prepared in this way is presented. (D.L.C.)

18251 (NAS-NRC-Pub-871 (p.273-6)) SILICON WAFERS FOR dE/dx DETECTORS. C. G. Phelps (Los Alamos Scientific Lab., N. Mex.).

Methods for preparing silicon wafers for dE/dx detectors are summarized: crystal mounting, slicing to 0.025 in. thickness, lapping the first surface, lapping the second surface to the final thickness, and removing wafers from the mounting block. (D.L.C.)

18252 (NP-7892) IRIA—STATE-OF-THE-ART REPORT. OPTICAL MATERIALS FOR INFRARED INSTRUMENTATION. Stanley S. Ballard, Kathryn A. McCarthy, and William L. Wolfe (Michigan Univ., Ann Arbor. Willow Run Labs.). Jan. 1959. 120p.

The properties of approximately fifty materials which are useful in optical instrumentation in the infrared portion of the electromagnetic spectrum are described and compared. Each material is discussed in detail in terms of its optical, chemical, thermal, and mechanical properties. Tables and figures are given so that the properties of the various materials can be readily compared. (auth)

18253 (NP-9995) ROENTGEN RATE METER. Interim Development Report for April 20, 1959 to July 20, 1959. (Daystrom, Inc. Weston Instruments Div., Newark, N. J.). Aug. 4, 1959. Contract NObsr-77566. 11p.

The selected requirements for a rugged roentgen rate meter to be used with AN/PDR series radiac equipment are set forth. Initial considerations of the design are presented and a study of the problem is outlined. (auth)

18254 (NP-9996) ROENTGEN RATE METER. Interim Development Report for July 20, 1959 to October 20, 1959. (Daystrom, Inc. Weston Instruments Div., Newark, N. J.). Nov. 12, 1959. Contract NObsr-77566. 10p.

The design concepts of a roentgen rate meter to be used with AN/PDR series radiac equipment are set forth. Design details are discussed for the following components: indicating mechanism, mounting base, rate-changing mechanism, and housing. (D.L.C.)

18255 (NP-9997) ROENTGEN RATE METER. Interim Development Report for October 20, 1959 to January 20, 1960. (Daystrom, Inc. Weston Instruments Div., Newark, N. J.). Feb. 10, 1960. Contract NObsr-77566. 9p.

Parts for initial test samples were fabricated for a roentgen rate meter for use with AN/PDR series radiac equipment, and mock-ups of portions of the initial design were assembled and subjected to test. Performance is analyzed

for the housing, zero corrector, range-changing drive shaft, back connection studs, and window. (D.L.C.)

18256 (NP-9998) ROENTGEN RATE METER. Interim Development Report for January 20, 1960 to April 20, 1960. (Daystrom, Inc. Weston Instruments Div., Newark, N. J.). Apr. 26, 1960. Contract NObsr-77566. 11p.

Sample instruments of the initial design for a roentgen rate meter for use with AN/PDR series radiac equipment were assembled and subjected to vibration, tumbling, and shock. The test results are analyzed for the housing, mounting base, indicating mechanism, and range-changing mechanism. (D.L.C.)

18257 (NP-9999) ROENTGEN RATE METER. Interim Development Report for April 20, 1960 to July 20, 1960. (Daystrom, Inc. Weston Instruments Div., Newark, N. J.). Aug. 5, 1960. Contract NObsr-77566. 19p.

Roentgen rate meters (Model 1509) for use with AN/PDR series radiac equipment were assembled and subjected to the environmental, vibration, tumbling, and shock tests of Specification MIL-M-10304A. Evaluations of pivots and window materials to the proposed MIL-M-10304B requirements and the range-changing mechanism toward reliability were performed. A performance analysis is presented. (auth)

18258 (NP-10000) ROENTGEN RATE METER. Final Engineering Report for July 20, 1960—August 31, 1960. (Daystrom, Inc. Weston Instruments Div., Newark, N. J.). Sept. 20, 1960. Contract NObsr-77566. 21p.

Twenty roentgen rate meters (Model 1509) for use with AN/PDR series radiac equipment were assembled. The characteristics and operation data for these meters are given. (D.L.C.)

18259 (NP-10098) AN ENGINEERING STUDY TO DETERMINE THE FEASIBILITY OF DEVELOPING A GAMMA-RAY CAMERA FOR AERIAL SURVEY. Initial (Final) Report—Phase I on GAMMA-RAY PINHOLE CAMERA; THEORETICAL INVESTIGATION, JULY 1, 1960 TO OCTOBER 1, 1960. E. J. Di Ianni and H. J. Cooley (Nuclear Corp. of America. Instrument and Research Div., Denville, N. J.). Contract DA-36-039-SC84977. 91p.

Work conducted on an engineering study to develop a gamma ray pinhole camera for aerial survey of contaminated areas is described. Included is a comprehensive discussion for both point and uniform infinite plane sources of gamma ray attenuation, angular and energy distribution of scattered flux, methods of calculating flux distribution, approximate and measured dose build-up factors, geometry considerations, and the effects of variations in atmospheric temperature and percent relative humidity. In addition, the desired characteristics of an aerial gamma camera are listed and discussed. Several methods of approach are proposed and evaluated with regard to meeting the basic gamma camera requirements and the feasibility of extending the camera operation to higher aircraft velocities and altitudes. Formulas are derived showing the basic aircraft altitude, velocity, resolution and sensitivity relationships including statistical requirements for instrument accuracy. A mathematical description of the Boltzman Transport equation and the "Moments Method" solution of this equation is presented. (auth)

18260 (NP-10126) NUCLEAR RADIATION EFFECTS INSTRUMENTATION TECHNIQUES. Richard G. Saelens and Louis Leo Kaplan (Army Signal Research and Development Lab., Fort Monmouth, N. J.). [1961]. 30p.

The effects of pulsed and steady-state nuclear radiation

on electronic parts, materials, and systems are discussed, and the irradiation facilities for studying these effects are described. Criteria of radiation damage are examined, and some of the various methods of recording and analyzing radiation effects are outlined. (D.L.C.)

18261 (NP-10137) DEVELOPMENT OF ULTRA RE-FRACTORY MATERIALS. Progress Report No. 24, February 1, 1961-April 30, 1961. Peter T. B. Shaffer (Carborundum Co. Research and Development Div., Niagara Falls, N. Y.). Apr. 28, 1961. Contract NOrd-17175. 12p.

The melting points of metal sheets of W, Ta, Mo, and Nb were measured in order to test the reproducibility of a melting point apparatus for a ZrC-TaC study. Melting point measurements were then made on bars of ZrC, TaC, NbC, TaC + 25 wt.% graphite, NbC + 25 wt.% graphite, and 4 TaC-ZrC. (D.L.C.)

18262 (NYO-9727) FLUOROSCOPIC CRYSTAL INVESTIGATION. Final Report, June 1, 1960 to March 8, 1961. (Nuclear Research Corp., Southampton, Penna.). [1961]. Contract AT(30-1)-2572. 27p.

An investigation was carried out on the possibility of increasing the light output of single crystals by applying an electric field throughout the crystal lattice. Pulses of frequency 2.5×10^5 cps were used with a voltage gradient of 10^4 volts/cm, and gamma radiation from Cs¹³⁷ and Co⁶⁰ was used to excite the crystals. Tests were run on many types of scintillators. The visible light output was found to be increased by electric pulses for many of the scintillators, the best results being obtained with ZnS(MnCl₂, AgCl) crystals. (D.L.C.)

18263 (SCR-283) GALVANOMETER ISOLATION PIER. J. T. Wilson and L. H. Bressan (Sandia Corp., Albuquerque, N. Mex.). Feb. 1961. 14p.

Presented at the ISA Winter Instrument-Automation Conference and Exhibit, St. Louis, Missouri, January 17-19, 1961.

An economical and portable shock and vibration isolation system was designed to isolate d-c reflecting-type galvanometers. Tests proved that the system is adequate. It is readily adaptable to many applications. (auth)

18264 (SCR-286) A FERRITE PIEZOMAGNETIC STRESS TRANSDUCER. Cecil E. Land (Sandia Corp., Albuquerque, N. Mex.). Mar. 1961. 17p.

A description is given of the piezomagnetic stress transducer and its operation. The phenomenological theory of the stress sensitivity of the ferrite sensor is explained. A qualitative relation between output voltage and mechanical stress in the ferrite sensor is derived. (auth)

18265 (SCTM-168-56-16) CRYSTAL ACCELEROMETER RESPONSE TO MECHANICAL SHOCK IMPULSES. A. F. Lawrence (Sandia Corp., Albuquerque, N. Mex.). Aug. 23, 1956. 10p. (M-6105).

Crystal accelerometers, when used with normal circuitry to measure shock impulses, will cause distortion of the shock waveform and if the shock curves are not properly interpreted and certain corrections applied, the results will be in error. A correction curve with which to determine the true positive peak of half-sine shock impulses is derived which when applied will reduce measurement error. Laboratory tests showed that for true reproduction of the shock impulse direct coupled circuitry is required, and it must have a very high input resistance (obtainable with an electrometer) to prevent current from being drawn from the crystal. It is concluded that the use

of the conventional cathode follower will cause the curve to have a reduced peak value and a shorter duration than the input impulse. Application of the correction curve will result in a value closer to the true peak value. (auth)

18266 (SRB-61-1) MICROMINIATURE OSCILLATORS. An Annotated Bibliography. George R. Evans, comp. (Lockheed Aircraft Corp., Sunnyvale, Calif.). Mar. 1961. 150p.

The compilation includes articles and reports which were written since 1950. The following indexes were checked: Aero/Space Engineering, 1959 to date; Aeronautical Engineering Index, 1950 to 55; Engineering Index, 1950 to date; IRE Proceedings; Abstracts and References, 1950 to date; Pacific Aeronautical Library: Uniterm Index, 1955 to date; Science Abstracts. B: Electrical Engineering, 1955 to date; Semiconductor Electronics, 1953 to date; and U. S. Government Research Reports, 1956 to date. 351 references. (auth)

18267 (TID-4901) CLOUD CHAMBERS. A List of Selected References to Technical Reports, Books and Journals. Henry D. Raleigh, comp. (Office of Technical Information Extension, AEC). Apr. 3, 1961. 7p.

A list of 33 selected references to technical reports, books, and journals on cloud chambers is presented. NSA abstract numbers are given for each reference. (M.C.G.)

18268 (TID-11862) THE DEVELOPMENT OF AN EXPLOSIVE ELECTRIC TRANSDUCER. PART I. EQUATION OF STATE OF QUARTZ. Final Report. G. R. Fowles (Stanford Research Inst. Poulter Labs., Menlo Park, Calif.). Jan. 10, 1961. For Sandia Corp. 36p. (SCDC-2235)

The Hugoniot equation of state of synthetic alpha quartz single crystals was determined with emphasis on the Hugoniot elastic limits. Quartz pellets were shocked by plane wave explosive systems and the resulting shock and free-surface velocities were observed with a rotating-mirror streak camera. Three orientations were investigated in which the direction of shock propagation is parallel to the X, Y, and Z crystallographic directions (electrical designations), respectively. The first shock wave is an elastic wave which gave stress amplitudes (Hugoniot elastic limits) of 60 ± 5 , 84 ± 2 , and 90 to 135 kb for the X, Y, and Z cut crystals, respectively. A second shock was directly observed in one experiment with Z cut pellets; it appears that a well-defined elastic limit for this orientation may not exist. Above the elastic limit, the material appears to lose rigidity entirely, implying that yield is not caused by motion of dislocations. (D.L.C.)

18269 (TID-12627) A LOW TEMPERATURE THERMOMETER UTILIZING THE MÖSSBAUER EFFECT. R. Dean Taylor (Los Alamos Scientific Lab., N. Mex.). [1961]. 22p.

An absolute thermometer for use in the region below 1°K is discussed. The recoil-free resonant emission and absorption of γ rays, known as the Mössbauer effect, was used to study the changes of the populations of the nuclear spin sub-levels at low temperatures. The intensity changes in the magnetic hyperfine spectrum are related to the number of nuclei in each sub-level and the populations of each sub-level depend on the Boltzmann factor. The theory is discussed for the case of a low-temperature source of Co⁵⁷ in Fe metal, with the 14.4-kev resonant γ ray in the decay scheme analyzed by a room temperature absorber containing Fe⁵⁷ and for the inverse case of a low-temperature Fe⁵⁷ absorber and a room temperature source. Experimental results confirmed the theory. Some advantages and limitations of the thermometer are presented. (auth)

18270 (TID-12631) A PRECISION PHOTON COUNTING PYROMETER. Leonard H. Treiman (Los Alamos Scientific Lab., N. Mex.). [1961?]. 18p.

A photon counting pyrometer capable of high precision from 1063 to 4000°C with very small targets was built. Counting plateaus for photons were obtained. The melting of gold was followed over a 40-min. period with a standard deviation of $\pm 0.077\%$ in photon intensity or better than 0.05° . (auth)

18271 (USNRDL-TR-495) A PORTABLE MULTI-PURPOSE RADIATION DETECTION INSTRUMENT. G. T. Kiyoi, K. F. Sinclair, and K. Miller (Naval Radiological Defense Lab., San Francisco). Feb. 16, 1961. 49p.

A portable high range multi-purpose radiation detection instrument is described. The device performs three separate functions: (1) measurement of gamma dose rate, (2) measurement of beta plus gamma dose rate, and (3) measurement of beta dose rate in the presence of gamma radiation (by means of gamma cancellation). The ranges of operation for each of these functions are 0 to 2, 0 to 10, 0 to 100, and 0 to 1000 rad/hr in tissue under selected physical conditions. The radiac consists of a dual ionization chamber detector, an electrometer amplifier, and two transistorized power supplies. It is powered by two type D flashlight batteries and will operate continuously in excess of 90 hours with 10% meter light operation. Performance data, design factors, and construction details of the instrument are discussed. (auth)

18272 (WAPD-BT-22(p.9-17)) THE USE OF NEUTRON-INDUCED REACTIONS IN ZIRCALOY AS FAST FLUX MONITORS. G. C. Owens (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

The effects of long-term, fast-neutron irradiation on structural Zircaloy used in operating cores have been the object of many test programs. Pure Ni and Fe flux monitor wires were irradiated in the program described, and the results of measurements from these wires were compared with the $\text{Ni}(n,p)\text{Co}^{58}$ and $\text{Fe}(n,p)\text{Mn}^{54}$ fast-neutron reactions induced in Zircaloy irradiated to the same flux. Close agreement was found between these results, and it is felt that this means of fast flux monitoring is a valid one which can be applied to other reactions and materials provided certain criteria are met. (auth)

18273 (WAPD-BT-22(p.45-59)) PRESSURE TRANSDUCER RESPONSE ANALYSIS. P. E. Litteneker (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

A new pair of equations to determine the response of differential pressure transducers is developed which takes into account changes in the size and temperature of the tubing connecting the pressure source with the transducer. The differential equation for the response of a transducer system is $W_n^2 X_0 \gamma = (d^2x/dt^2) + 2 W_n h (dx/dt) + W_n^2 x$ where γ is the time-varying driving force. The solution for the equation is presented for the three most common driving forces for systems which are underdamped, critically damped, or overdamped. The calculated step-function response agrees very closely with the response obtained from a laboratory transducer system. (auth)

18274 (WAPD-BT-22(p.61-70)) PARALLEL TRANSDUCER RESPONSE ANALYSIS. Jesse Lopez (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

Frequency data from reactor coolant flow coastdown are compared with that obtained from an electrical analog to confirm the method of analysis. The results show that the

analysis is satisfactory for the construction of an electrical analog that depicts the actual system to an acceptable degree of accuracy. (auth)

18275 (AEC-tr-4432) RADIOMETRY. Vladimir I. Baranov (Akademiya Nauk S.S.S.R. Institut Geokhimii i Analiticheskoi Khimii im. V. I. Vernadskogo). A translation of the Publishing House of the Academy of Sciences, USSR. Moscow, 1956. 391p.

The basic concepts of radioactivity and methods of measuring radioactive irradiation are presented. Particular attention was paid to procedures for laboratory radiometric analysis of rock specimens, to field radiometric methods, and to the application of radioactive methods in geology. Instruments and basic methods for radiometric analysis and prospecting are described in detail. Safety techniques are also reviewed. (M.C.G.)

18276 (AEC-tr-4471) OPTICS IN EQUIPMENT FOR THE UTILIZATION OF SOLAR ENERGY. V. B. Veinberg. Translated from a publication of the State Publishing House of Defense Industry, Moscow, 1959. 257p.

A study was made of the development of solar engineering, the feasibility of projects, and conditions for application of solar energy. Data concerning solar radiation on the USSR are included. Methods are given for determining the most beneficial construction parameters for concentrating solar rays and for systems for transparent heat insulation. Methods are proposed for calculating the output of solar equipment. Devices simulating natural lighting conditions were examined by investigating structural models. Recommendations are given for the orientation and inclination of receivers, the design of buildings, and the choice of types of transparent insulation and windows. (auth)

18277 (CEA-tr-R-1077) MODÈLES INDUSTRIELS DE DÉTECTEURS DES NEUTRONS THERMIQUES ET DES NEUTRONS RAPIDES. (Industrial Models of Thermal- and Fast-Neutron Detectors). V. S. Filonov. Translated into French by B. Vinogradoff from Izvest. Akad. Nauk S.S.S.R. Ser. Fiz., 22: No. 1, 94-6(1958). 9p.

The parameters and characteristics of commercial fast-neutron and thermal-neutron detectors are tabulated and graphed. (J.S.R.)

18278 (CEA-tr-R-1138) ELEVATION DE LA SENSIBILITE DES MATERIAUX PHOTOGRAPHIQUES PAR HYPERSENSIBILISATION AVEC DE LA TRIETHANOLAMINE. (Increase of the Sensitivity of Photographic Materials by Hypersensitization with Triethanolamine). I. I. Breido. Translated into French by B. De Trezvinsky from Zhur. Nauch. i Priklad. Fot. i Kinematografii, 3: No. 3, 224-5 (1958). 5p.

Fifteen types of photographic materials were bathed in 2% triethanolamine solution, dried rapidly, and exposed in a sensitometer with exposure times from 0.05 to 750 sec. The inversion variation during long exposures was represented by the ratio S_1/S_2 for primary material and by S_1^1/S_2^1 for hypersensitized material (S_1 and S_1^1 is the sensitivity at 0.05 sec and S_2 and S_2^1 at 750 sec). In all cases S_1^1/S_2^1 is inferior to S_1/S_2 , that is the triethanolamine hypersensitization reduces the variation of the inversion for long exposures. The hypersensitization is more efficient for long exposures and is most efficient for materials in which the inversion variation is large during long exposures. (J.S.R.)

18279 (CEA-tr-R-1149) ACCROISSEMENT DE LA SENSIBILITE ET DE LA REGULARITE DU DEVELOPPEMENT DE L'EMULSION DE TYPE P A L'ETAT COLLE. (Increase of the Sensitivity and the Uniformity of Development of P-type Emulsion in the Mounted State). D. M.

Samoilovich, E. S. Barinova, A. A. Vlasov, and O. P. Inkhrovskaya (Iukhnovskaia). Translated into French from Zhur. Nauch. i Priklad. Fot. i Kinematografii, 5: No. 2, 142-3(1960). 6p.

It has been shown that emulsions developed in the mounted state have less sensitivity and less regularity of track development than emulsions developed without support. The pH of P-type emulsion is 4.5 to 4.7, and this pH can cause the non-development of tracks in the depths of the emulsion. In order to regularize the development within the emulsion and to increase the sensitivity, a basic solution was used before drying to increase the pH to 6.5 to 6.7. The results obtained in the measurement of the track density for emulsions at different pH are tabulated. The regularity of the development of the tracks in the middle of the emulsion at a high pH was entirely satisfactory. The sensitivity was considerably increased. (J.S.R.)

18280 (CEA-tr-R-1156) ANALYSEUR EN TEMPS À VINGT CANAUX POUR LA SÉLECTION DE NEUTRONS RAPIDES EN FONCTION DU TEMPS DE TRANSIT. (20-Channel Time Analyzer for Selection of Fast Neutrons As a Function of Transit Time). A. I. Veretnnikov and V. Ya. (Ia.) Averchenkov. Translated into French by B. De Trezinsky from Priboi i Tekh. Ekspt., No. 3, 48-53(1958). 19p.

A multi-channel time analyzer, constructed on the principle of time-amplitude transformation is described. The scheme proposed by Neilson and James (Rev. Sci. Instr. 28: 1018(1955)) is completed by elements measuring the selection of input pulses of a definite order. The practical resolution time is 1.5 to 3 msec with electrical resolution time of 0.45 msec. The instability of the limits of the channels is 0.5 msec. The analyzer selects neutrons from a Po-Be source according to the transit time. (tr-auth)

18281 (JPRS-9084) NEW INSTRUMENTS FOR THE SAMPLING OF ATMOSPHERIC AIR FOR RADIOACTIVITY. Yu. V. Novikov and M. L. Godovich. Translated from Gigiena i Sanit., 25: No. 11, 47-50(Nov, 1960). 8p.

A particle collector is described which consists of a centrifugal air blower and filters. A portable model was developed for use in the fluid. The apparatus gave good performance in atmospheric sampling for artificial radioactive aerosols. (C.H.)

18282 (UCRL-Trans-651(L)) POSITION AND VISIBILITY OF WEDGE INTERFERENCES IN INSTRUMENTAL OBSERVATIONS (CONTRIBUTION TO THE COHERENCE THEORY OF AN UNSYMMETRICAL INTERFERENCE CASE). Rudolf Landwehr. Translated from Optica Acta (Paris), 6: No. 1, 52-76(Jan. 1959). 54p. (Includes original, 25p.).

In view of modern possibilities for increasing the accuracy of interference measuring, the most important results of the older, practically unknown work of Ingatowsky are given and discussed in connection with recent publications on coherence theory. New curves, calculated for characteristic examples, show the whole course of the coherence terms (change of phase and visibility) in the respective unsymmetrical interference case. The representation also extends to greater phase differences. Special reference is given to the kind of interaction of two interference systems, e.g., in the measurement of final masses. (auth)

18283 A PROPORTIONAL LIQUID EFFLUENT SAMPLER FOR LARGE-VOLUME FLOWS. H. H. Abee and J. C. Hart (Oak Ridge National Lab., Tenn.). Am. Ind. Hyg. Assoc. J., 22: 133-5(Apr. 1961).

A proportional sampler for large-volume liquid flows has been designed, installed, and tested at the White Oak Creek

Dam. The basic unit consists of a circulating pump and a collecting vessel controlled by an overflow pipe which varies in height in proportion to the head of the stream. The sampling period is normally 10 minutes and can be adjusted for optimum conditions by regulating the timing mechanism. It is adaptable to wide variations in stream head, requires little maintenance, and minimizes clogging resulting from debris, incrustation, and algae formations. (auth)

18284 TRANSISTOR ALPHA-PARTICLE DETECTOR. C. S. Ananiades and J. W. Dewdney (Dartmouth Coll., Hanover, N. H.). Am. J. Phys., 29: 329(May 1961).

An α particle detector for demonstration purposes is described. It utilizes an n-p-n junction transistor and a commercial amplifier. A Po^{210} source produces pulses large enough to operate a mechanical register, flash a neon lamp, be heard on a loudspeaker, and be seen on an oscilloscope screen. (T.F.H.)

18285 A COINCIDENCE CIRCUIT WITH MEDIUM VELOCITY. J. A. Pajares (Junta de Energia Nuclear, Madrid). Anales real soc. espan. fis. y quim (Madrid), Ser. A., 56: 243-8(Sept.-Oct. 1960). (In Spanish)

A coincidence circuit with a variable resolution time between 0.2 and 1 μsec , employing the dual-control tube 6BN6, is described. Curves showing amplitude ratio between coincidence and single output pulses versus 6BN6 plate load are given. Coincidence pulse height as a function of time between input pulses is shown. (auth)

18286 PRINCIPLE OF "ELECTRONIC GATES" IN FAST SCALERS WITH DECIMAL INTERPOLATION. Wsewolod Warzanskyj (Junta de Energia Nuclear, Madrid). Anales real soc. espan. fis. y quim (Madrid), Ser. A, 56: 257-64(Sept.-Oct. 1960). (In Spanish)

A decimal counting unit with 1 μsec resolving time is described. It contains a pulse-forming circuit, four flip-flops, and a gate. Reliability is the main feature of the circuit. (auth)

18287 A FAST CHOPPER AND ITS USE IN THE MEASUREMENT OF NEUTRON SPECTRA. E. Johansson, E. Lampa and N. G. Sjöstrand (AB Atomenergi, Stockholm). Arkiv Fysik, 18: 513-31(1961). (In English)

The fast chopper installed at the Swedish natural uranium-heavy-water reactor R1 is described. Its neutron properties as determined from measurements and calculations are discussed. The chopper is used to measure the neutron spectrum in a beam from the central channel of the reactor. The beam was extracted from scatterers of water, heavy water, graphite, or lead placed in various positions in the channel. It was found that the thermal spectrum can be fitted accurately to a Maxwell distribution. The epithermal spectrum from lead and graphite scatterers follows the $1/E$ law within 1% in the region 2 to 10 eV but deviates from this law at higher energies, probably because of the resonance absorption in uranium. The shape of the function joining the Maxwell and $1/E$ parts together was studied in detail. The effective starting point of the $1/E$ spectrum was found to be (3.6 ± 0.4) kT, where T is the neutron temperature. Supplementary measurements with foils and counters showed that the beam spectrum from graphite or lead scatterers is very closely the same as the spectrum in the empty channel. The neutron temperature in the channel was found to be 29 ± 10 degrees above the moderator temperature and the epithermal fraction β was obtained as 0.0420 ± 0.0015 . (auth)

18288 TEMPERATURE DEPENDENCE OF SCINTIL-

LATION COUNTERS. H. Schneider and H. Wassel (Universität, Giessen, Ger.). *Atomkernenergie*, 6: 98-100 (Mar. 1961). (In German)

The temperature dependence of parts of the scintillation counters (photomultiplier tube, crystal, and voltage divider) was measured by recording the pulse height at the working resistance of the photomultiplier tubes and recording the mean direct-current. Photomultiplier temperature coefficients varied from -0.15 to -0.45% $^{\circ}\text{C}$ in the range 20° to 40°C , while those of the crystals CsI(Tl) and NaI(Tl) rose with increasing temperature when measuring the pulse height. The difference of the last effects by varying the working resistance was tested too. When measuring the difference of the mean voltages, it was found that the temperature coefficient of CsI(Tl) is different from that of NaI(Tl) . (auth)

18289 THE VISUAL REPRESENTATION OF THE MOTION OF RADIOACTIVE SUBSTANCES IN INACCESSIBLE SPACES. A. Scheidweiler (Technische Hochschule, Aachen). *Atomkernenergie*, 6: 104-8 (Mar. 1961). (In German)

The application of radioactive isotopes in research and industry has influenced the entire electronic counting technique to a great extent within the last few years and had led to the development of a number of completely new counting methods. In particular, the case should be considered when the motion of solid, liquid, or gaseous substances is to be observed in inaccessible spaces. For this purpose, the substance to be observed is labeled with a certain radioactive isotope, the radiation of which is measured at an easily accessible spot. With the aid of an electronic method especially designed for this purpose, the space-time distribution of the activity $A = A(x, y, z, t)$ is shown on a visual apparatus. The selection of isotopes is determined by the case under consideration, but in most cases γ rays are used. (auth)

18290 PAPER-CHROMATOGRAM MEASUREMENT OF SUBSTANCES LABELLED WITH H^3 . Martin Wenzel (Freie Universität, Berlin). *Atompraxis*, 7: 86-8 (Mar. 1961). (In German)

Compounds labelled with H^3 can be detected with a paper chromatogram using a methane flow counter with a count yield of 1%. The yield can be estimated from the beta maximum energy. A new double counter was developed which increases the count yield to 2% and also considerably decreases the margin of error. Calibration curves with leucine and glucosamine show satisfactory linearity between measured and applied activity in the range from 4 to $50 \times 10^{-3} \mu\text{C}$ of H^3 . (auth)

18291 THE DETERMINATION OF THE MAXIMUM ENERGY OF BETA RADIATION BY THE MEASUREMENT OF THE HALF THICKNESS OF REAL ABSORPTION. L. Danguy, J. Franeau, and A. Lhost (Centre de la Faculté Polytechnique de Mons, Belg.). *Bull. classe sci., Acad. roy. Belg.* (5) 46: 774-90 (1960). (In French)

An experimental study of real β absorption shows that in the energy range 0.171 to 1.701 Mev absorption is independent of the nature of the absorbant if thickness is expressed in mg/cm^2 , if the absorbants are sufficiently thin, and if the solid angle of the incident beam is small. In these conditions, the half thickness of real absorption $X_{1/2}$ is proportional to E_{\max} of the β radiation with the relationship $E_{\max} (\text{Mev}) = 0.0143 X_{1/2} (\text{mg}/\text{cm}^2)$. (tr-auth)

18292 GLOW-TUBE PROGRAMMER CONTROLS NEUTRON SPECTROMETER EXPERIMENTS. Edward W. Johanson (Argonne National Lab., Ill.). *Electronics*, 34: No. 19, 65-7 (May 12, 1961).

An electronic system is described that programs output data of a neutron diffractometer. The neutron beam is passed through a fission detector, strikes the target, and is diffracted to the BF_3 detector. The fission detector, diffractometer, and scattering angle data are fed to the programmer. Programming of the fission detector data eliminates neutron flux variation errors. The programmer uses multi-cathode glow-transfer tubes as switches or control devices. (T.F.H.)

18293 PLASTIC SCINTILLATORS IN DOSIMETRY OF INTENSE γ RADIATION BEAMS. R. Dugnani Lonati (CISE, Segrate, Italy) and G. Skoff. *Energia nucleare (Milan)*, 8: 188-95 (Mar. 1961). (In English)

To determine the isodose curves in materials exposed to a beam of intense gamma radiations, the light generated in a plastic scintillator is used. The plastic is photographed, and from the blackening produced in the various points of the film, the dose absorbed in the corresponding points of the plastic is determined. Already used in the case of irradiation with Co^{60} , this method is now used for irradiating with tubes of Ra and for mixed irradiation with Ra + Co^{60} . (auth)

18294 ON THE OPERATION OF THE DISCHARGE CHAMBER. F. T. Arecchi, G. Cavalleri, E. Gatti, and G. Redaelli (CISE, Segrate, Italy). *Energia nucleare (Milan)*, 8: 213-16 (Mar. 1961). (In English)

The tracks observed in the discharge chamber have a slight S shape and some exhibit branches. It was suggested that the first type of track is due to streams channeled along the ionized tracks, to real and proper filament-shaped discharges. The second is due to a local avalanche multiplication of the electrons initially formed for alpha particles. The design of the discharge chamber constructed to conform these assumptions is given in some detail, and the results are described. (J.S.R.)

18295 A LOW PRESSURE EXPANSION CLOUD CHAMBER. M. Rama Rao (Saha Inst. of Nuclear Physics, Calcutta). *Indian J. Phys.*, 35: 92-100 (Feb. 1961). (In English)

A pressure defined expansion cloud chamber was constructed and operated satisfactorily up to total pressures of 5 cm of Hg. The best track conditions for different total pressures as a function of the expansion ratio are determined and discussed using ethyl, n-butyl, and iso-amyl alcohols as condensant vapor and argon as permanent gas. Photographs of Po^{210} tracks taken at 5 cm of Hg with iso-amyl alcohol and argon mixture are presented. (auth)

18296 IONIZATION α SPECTROMETER WITH HIGH RESOLVING POWER. G. E. Kocharov and G. A. Korolev (Inst. of Physics and Tech., Academy of Sciences, USSR). *Izvest. Akad. Nauk S.S.S.R., Ser. Fiz.*, 25: 237-56 (Feb. 1961). (In Russian)

A high-resolving-power α -spectrometer is described. Factors influencing the resolving power were analyzed and formulas were developed for determining the half-width of the α line and the maximum shift magnitude. The proper selection of the first tube and the operating conditions reduced the noise to a half-width of 16 kev. The use of an argon-methane mixture eliminated the adherence of electrons to electronegative admixtures. An increased drift rate improved and electric collimation improved the resolving power. The spectra of U^{234} and U^{235} α particles obtained with the spectrometer are plotted, and the results for Th and U α spectra are tabulated. The parameters of Ra²²⁸ and Th²³⁰ were determined. Correlations are made of theoretical and experimental probabilities of α transitions to the 4^+ level in even Ra and Th nuclei. (R.V.J.)

18297 MERCURY γ CALORIMETER. E. A. Khol'nova (Mendeleev All-Union Research Inst. of Metrology, [USSR]. *Izvest. Akad. Nauk S.S.S.R., Ser. Fiz.*, 25: 257-60 (Feb. 1961). (In Russian)

Descriptions are given of a mercury γ calorimeter and its performance is compared with a lead calorimeter. It is shown that the absorption properties of the mercury calorimeter are identical to the lead and the thermal properties are better. The heat exchange surface and general heat capacity of the mercury calorimeter is smaller but the temperature sensitivity is higher by a factor of one. The mercury calorimeter is capable of measuring the activity of preparations (for example Co^{60}) of 2 to 5 mc. (R.V.J.)

18298 DOUBLE CRYSTAL SPECTROMETER AND ITS APPLICATIONS IN STUDYING (p, γ) REACTIONS. Yu. P. Antuf'ev, V. Yu. Gonchar, E. G. Kopanets, A. N. L'vov, and S. P. Tsytko (Inst. of Physics and Tech., Academy of Sciences, Ukr. SSR). *Izvest Akad. Nauk S.S.S.R., Ser. Fiz.* 25: 261-4 (Feb. 1961). (In Russian)

The design and performance of a double crystal γ spectrometer with a universal block-scheme and performing as both a coincidence and integrating spectrometer are described. Two crystals of NaI(Tl) , one 70 mm in diameter and 60 mm high with 11% resolving power at 661 keV and another 70 mm in diameter and 40 mm high with 14% resolving power at the same energy, are used. The spectrometer performance was checked with Co^{60} and the coincidence spectrum for γ rays at 1.33 MeV was plotted. The experimental and theoretical data coincided within $\pm 15\%$. The spectrometer was also used for measuring the γ spectra from $\text{Al}^{27}(p, \gamma)\text{Si}^{28}$. The resonance γ rays at $E_p = 993.3$ keV were studied. Cascade transitions through 1.78 and 4.6 MeV were analyzed, and the latter was found to be about 5% of the former. The spectrometer can be utilized as a Compton γ spectrometer and as a total absorption spectrometer. (R.V.J.)

18299 GLASS SCINTILLATOR FOR NEUTRON DETECTION. Adli M. Bishay (Argonne National Lab., Ill.). *J. Am. Ceram. Soc.*, 44: 231-3 (May 1961).

A glass scintillator which can be used as one of the main components of a slow-neutron time-of-flight spectrometer was developed. Sodium aluminoborate glass containing 73 mole % B_2O_3 and 8.0 mole % Ce was melted under highly reducing conditions in a series of cerium-activated very high boron-containing glasses. The glass is water white with very high light transmittance for wave lengths greater than 3800 Å. It has a neutron-detection efficiency which is 25 to 30% greater than any other known glass scintillator in the energy range 10^2 to 10^4 eV, and is considerably better than any other type of detector. It was found that the neutron pulse height increases with increasing cerium content up to a maximum and then decreases with further increases in the cerium content. The molar content of cerium required to obtain a maximum pulse height for each B_2O_3 concentration increases linearly with the increase in the B_2O_3 content. However, the maximum pulse height decreases gradually with the B_2O_3 content from 17.0 arbitrary units at 54.5 mole % to 6.7 at 73.4 mole %. This lower pulse height is still considerably above the photomultiplier noise at room temperature. (auth)

18300 USE OF PrCl_3 IN A SOLID STATE INFRARED QUANTUM COUNTER. John F. Porter, Jr. (Johns Hopkins Univ., Baltimore). *J. Appl. Phys.*, 32: 825-6 (May 1961).

A survey of the salts of the rare-earth series shows that anhydrous PrCl_3 has energy levels and selection rules suit-

able for use in a solid state infrared quantum counter. Two suitable schemes are proposed, one for detection at 2.33μ and a second for detection at 104μ . Consideration is given to isolation of the final detector signal from the pumping signal. A suitable experimental arrangement for unambiguously determining proper operation is shown. (auth)

18301 DEVELOPMENT AND PRELIMINARY TESTING OF A DEVICE FOR ELECTROSTATIC CLASSIFICATION OF SUBMICRON AIRBORNE PARTICLES. G. Langer and J. L. Radnik (Illinois Inst. of Tech., Chicago). *J. Appl. Phys.*, 32: 955-7 (May 1961).

An apparatus is developed for electrostatic size classification of aerosol particles of 0.1 micron to a few microns in diameter. The aerosol, surrounded by a sheath of clean air, is charged by passing it closely over an intense positive discharge at high speed. It enters an electrostatic field between parallel plates as a fine filament at 1 m/sec. Charging rates several times above those predicted by conventional theory permit good resolution. A high natural charge on the aerosols has an adverse effect on classification. Various aerosols are examined, and results of practical significance are obtained. With salt aerosols, strong, higher-order Tyndall spectra are observed from the classified deposit. (auth)

18302 SUPERIMPOSED OPTICAL AND GAMMA-RAY-SCANNER IMAGES. Hal O. Anger and George M. Tislar-Lentulis (Univ. of California, Berkeley). *J. Nuclear Med.*, 2: 99-101 (Apr. 1961). (UCRL-9255).

An apparatus is described which automatically superimposes an optical photograph of a patient on the gamma-ray image produced by whole-body gamma scanning after the injection of tracer doses of I^{131} . The site of I^{131} uptake is accurately located by this method. (C.H.)

18303 PROPERTIES, AT AMBIENT TEMPERATURE, OF IONIZATION CHAMBERS FILLED WITH DIELECTRIC LIQUID. D. Blanc, J. Mathieu, and J. Boyer (Faculte des Sciences, Toulouse). *Nuovo cimento* (10), 19: 929-38 (Mar. 1, 1961). (In French)

Properties of ionization chambers with parallel plane electrodes, filled with highly purified hexane are examined. At 26°C , the remanent current density (background) is $2 \cdot 10^{-14}$ amp/cm² when an electric field of 8.2 kv/cm is applied. A 12 millicurie source of Co^{60} is situated in the middle of one of the electrodes, which makes the ionization current a hundred times greater than the remanent current. The Jaffé theory can be applied for fields up to 20 kv/cm. Above this field value, an amplification effect is observed that can be compared to the multiplication process in gaseous fillings. The pulses produced by 5.3 MeV α particles are shown in the region where this amplification effect exists. For electric fields from 25.6 kv/cm to 65.6 kv/cm, the amplitudes of impulses are between 25 and 250 μV and the rise times between 5 and 20 μs . (auth)

18304 VELOCITY DEPENDENCE OF TRACK DENSITY IN PROPANE AND HYDROGEN BUBBLE CHAMBERS. A. Ahmadzadeh and N. N. Biswas (Univ. of California, Berkeley). *Nuovo cimento* (10), 19: 958-70 (Mar. 1, 1961). (In English). (UCRL-9411)

A study of ionization data for charged particles is made in an underexpanded propane and a normally operated hydrogen bubble chamber. The gap-length distribution is found to be exponential over a wide range of velocity intervals, and the coefficient of this distribution gives a measure of the true track density, g ; g is proportional to β^{-n} , where β is the particle velocity and $n = 1.71 \pm 0.11$ for propane and 1.86 ± 0.37 for hydrogen. The density of

gaps, G, or of blobs, B, defined with objective criteria, shows a dependence on g , namely $G(\epsilon) = \text{density of gaps of length } \geq \epsilon = g \exp [-g(\alpha + \epsilon)]$; $G(\epsilon)$ passes through a maximum value, the position of which is related to the minimum resolvable gap distance α (approximately the average diameter of individual bubbles). The mechanisms of energy loss or δ -ray formation for the process of bubble nucleation are discussed in view of these measurements. The track density g is found to be approximately proportional to the rate of energy loss per unit length; this indicates that the bubble nucleation process may not be as simple as previously considered. (auth)

18305 STUDIES ON THE SENSITIZATION OF PHOTOGRAPHIC EMULSIONS TO X-RAYS BY THALLOUS SALTS. Yasuo Wakabayashi (Konishiroku Photo Ind. Co., Ltd., Tokyo). *Phot. Sci. Eng.*, 4: No. 1, 1-4 (Jan.-Feb. 1960).

It has been reported that divalent lead ions coprecipitated with silver bromide increases the x-ray sensitivity of a photographic emulsion and decreases the degree of solarization. It was found that there is a close correlation between solarization by light and sensitization to x rays. It was hypothesized that if the heightened x-ray sensitivity were a consequence of keeping positive holes from recombining with electrons, solarization would be decreased. With this in mind, the sensitization of silver bromide emulsions to x rays by other metal salts such as thallous nitrate and thallous bromide, and the solarization of the emulsions thus sensitized, were studied. The thallium salts sensitized the emulsions to x-ray exposure but not to light, and decreased or eliminated solarization by light. (auth)

18306 EFFECT OF CHEMICAL RIPENING ON THE PHOTOGRAPHIC RESPONSE TO LIGHT, X- AND GAMMA RADIATION. D. A. Nepela and H. F. Nitka (Ansc Research Labs., Binghamton, N. Y.). *Phot. Sci. Eng.*, 4: No. 1, 12-18 (Jan.-Feb. 1960).

Latent-image formation in a silver bromide emulsion was studied at various stages of chemical ripening when exposed to different radiation energies (high- and low-intensity light, x and gamma radiation). Surface, internal, and commercial development were applied, in addition to physical development. Chemical ripening, known to improve the surface sensitivity of the silver halide crystals for exposures to light, is more important for exposure to gamma radiation than for x-ray exposures. In this respect, gamma radiation exposures are more closely related to exposures to light than to x-ray exposures. This result is interpreted in the light of present knowledge of the mechanism of latent-image formation. (auth)

18307 AN AUTOMATIC GAMMA-RAY SENSITOMETER USING COBALT-60 FOIL SOURCES. V. G. McIninch and H. M. Cleare (Eastman Kodak Co., Rochester, N. Y.). *Phot. Sci. Eng.*, 4: No. 2, 78-85 (Mar.-Apr. 1960).

A sensitometer is described for exposing film between lead-foil intensifying screens in a four-step series, using thin cobalt-60 foils as the radioactive sources. With source activities of about 7 millicuries, exposure times for industrial-type x ray films range from 10 to 200 sec. Film samples in lead-screen cassettes are stacked in a hopper outside the source shielding. From the hopper they are automatically transported to the exposing position in sequence, exposed, and discharged outside the shielding. Shielding is sufficient to reduce the radiation to a factor of two or three above background. The mathematical theory of the sensitometer design is presented. (auth)

18308 THE EFFECT OF GAMMA-RAY EXPOSURE ON CAMERA FILMS. G. M. Corney (Eastman Kodak Co.,

Rochester, N. Y.) *Phot. Sci. Eng.*, 4: 291-5 (Sept.-Oct. 1960).

A gamma-ray fog tends to reduce the effective contrast and speed of a photographic material and to increase the graininess. The consequences of the first two effects can be minimized by proper choice of printing-paper grade and by increasing camera exposure, with the result that the increase of graininess may be the limiting factor. A film for use in the presence of gamma rays should have as low a speed as lens and exposure-time requirements will permit. Additional desirable features are: a high ratio of light to gamma-ray sensitivity, a high contrast, and a long density range over which the useful gradient is maintained. (auth)

18309 ANOMALOUS REFLECTIONS IN A SINGLE CRYSTAL NEUTRON SPECTROMETER. V. P. Duggal, K. Raghavendra Rao, C. L. Thapar, and V. Singh (Atomic Energy Establishment, Trombay, India). *Proc. Indian Acad. Sci., Sec. A*, 53: 59-72 (Feb. 1961). (In English)

The counting rate vs. Bragg-angle curve obtained with a single crystal neutron spectrometer shows fluctuations. Several of these fluctuations are identified as due to double Bragg-reflections by the crystal. The values of differential coherent inelastic scattering cross section of an Al (111) are obtained at a few angles for many incident neutron energies. The effect of this is found to be very small. (auth)

18310 AMPLITUDE-TIME SELECTION OF PULSES FOR THE STUDY OF INTERACTION OF NEUTRONS FROM THE $D(T, d)He^4$ REACTION WITH ATOMIC NUCLEI. V. V. Bobir, L. Ya. Grona, and V. I. Strizhak (Inst. of Physics, Academy of Sciences, Ukrainian SSR). *Ukrain. Fiz. Zhur.*, 5: 591-6 (Sept.-Oct. 1960). (In Ukrainian)

A method is described for the amplitude-time selection of pulses for the study of the interaction of fast neutrons from the $D(T, d)He^4$ reaction with atomic nuclei. Employing as detectors of neutrons and α -particles stilbene crystals and photomultipliers FEU-33, a time resolution of 1 nsec and an energetic resolution of 7 per cent were attained. The developed method was applied for measurement of the differential sections of elastic scattering of 14 Mev neutrons on bismuth over a range of angles of 20 to 115°. The experimental results are corrected for error due to finite geometry and the configuration of the initial neutron beam, and are compared with the theoretical curve constructed on the basis of the optical model of a nucleus with potential proposed by Bjorklund and others. (auth)

18311 PRODUCTION OF LARGE CADMIUM SULFIDE MONOCRYSTALS FOR GAMMA FIELD DOSIMETRY. I. D. Konozenko and V. I. Ustyanov (Inst. of Physics, Academy of Sciences, Ukrainian SSR). *Ukrain. Fiz. Zhur.*, 5: 606-14 (Sept.-Oct. 1960). (In Ukrainian)

In view of the deficiencies of the procedures developed for obtaining cadmium sulfide crystals [1, 2, 5] the authors have worked out a technology for producing large monocrystals of cadmium sulfide with homogeneous electrical, gamma electrical and photoelectrical properties. The depths of the impurity levels of these crystals were determined by measurements of the dependence of the dark electric conductivity on the temperature and the heat-stimulated conductivity. These crystals are shown to belong to the hexagonal lattice type as regards structural properties. (auth)

18312 NEW THERMIONIC IONIZATION GAUGE. N. A. Florescu (Univ. of New South Wales, Sydney). *Vide*, 16: No. 91, 10-17 (Jan.-Feb. 1961). (In French)

A new design of ionization gage is described in which the two electrodes, acting as electron emitter and ion collector,

respectively, are placed inside the positive grid having the form of a helical coil. A convenient construction is obtained by using two similar filaments, either one of which can be used as the ion collector. A thorough degassing being easily achieved, the gage is suitable for the measurement of extreme vacua. (auth)

18313 BARKHAUSEN OSCILLATIONS IN IONIZATION GAUGES. J. Pierre. Vide, 16: No. 91, 18-22 (Jan.-Feb. 1961). (In French)

It is noted that under certain conditions VHF oscillations occur in triode-type ionization gages. These oscillations are undesirable because they change gage sensitivity, and because supply leaks disturb their operation. The oscillations and their elimination in ionization gages are studied. (auth)

18314 RADIOACTIVE INDICATORS AS DETECTORS IN RADIOCHEMICAL INVESTIGATIONS IN THE X-RAY REGION. Walter Nägele (Technische Hochschule, Stuttgart). Z. physik. Chem., 27: 402-20 (Mar. 1961). (In German)

The possibility of using radioactive indicators as sensitive analytical detectors in radiochemical reactions, especially for chemical dosimetry, was investigated. Chloroform-water dosimeters with Cl^{36} -labeled chloroform were studied first. No advantage could be found with respect to the sensitivity as compared with the usual methods. Thallium(III) sulfate in sulfuric acid solution, labeled with Tl^{204} , appears usable for dosimetric purposes. The Tl^+ ion formed in the irradiation was chemically separated and measured. Doses to about 10 r could be detected. Very high requirements must be placed on the purity of the solution. The G values found are independent of the concentration within the region 10^{-4} to 10^{-6} M for radiation between 0.2 and 1.5 A and for doses between 6 and 80 r/min. Organic additions exerted a strong sensitizing effect on the radiochemical thallium reduction. (tr-auth)

18315 HIGH-INTENSITY GAMMA RAY DOSIMETRY. D. Hale (Wright Air Development Div., Wright-Patterson Air Force Base, Ohio), D. R. Johnson, S. M. Dec, J. R. Coss, O. V. P. Sessoms, P. B. Hemmig, W. L. R. Rice, and R. E. Brocklehurst. p.82-95 of "Symposium on Radiation Effects and Radiation Dosimetry." Philadelphia, American Society for Testing Materials, 1960.

High-intensity gamma dosimetry systems are briefly discussed. Systems described are the dye-glass dosimeter, gas-evolution dosimeter, optically-active organic compound dosimeters, neutralization dosimeter, induced uv absorption in methyl methacrylate, isothermal calorimeter dosimeter, CdS photoconductivity dosimeter, and the micro-wave ion chamber. These systems offer certain advantages in cost and performance and may be used in various fields for determining gamma dose rates. (N.W.R.)

18316 NEUTRON DOSIMETRY FOR MATERIALS IRRADIATION STUDIES. L. E. Steele and J. R. Hawthorne (Naval Research Lab., Washington, D. C.). p.111-28 of "Symposium on Radiation Effects and Radiation Dosimetry." Philadelphia, American Society for Testing Materials, 1960.

The correct interpretation of radiation effects upon materials depends upon accurate knowledge of neutron exposures. An analysis of the problems associated with neutron dosimetry for materials irradiation experiments in research reactors is presented along with a discussion of neutron flux data as a factor in the experimental environment. Some of the problems presented include: choosing the best monitors, interpreting preliminary neutron flux

surveys, measuring and interpreting flux levels under changing reactor conditions, and using flux data in the analysis of radiation effects. These problems are discussed, citing examples from practical experience in the Argonne CP-5 Reactor, the Brookhaven Graphite Reactor, the Oak Ridge Low-Intensity Test Reactor (LITR), and the Materials Testing Reactor (MTR). (auth)

18317 NEUTRON SPECTRUM DETERMINATIONS AT LOW FLUX LEVELS. Paul Kruger (Nuclear Science and Engineering Corp., Pittsburgh). p.129-44 of "Symposium on Radiation Effects and Radiation Dosimetry." Philadelphia, American Society for Testing Materials, 1960.

Theoretical and experimental considerations used in selecting threshold foils for determining neutron spectra where the flux is as low as one neutron per sq cm-sec are outlined. Special foils are used for measurements of neutron spectra in radioisotope sources, spent fuel element gamma irradiation facilities, and in electron linear accelerators. Activation foils are quite sensitive to neutrons, but they are generally unresponsive to high-level gamma fluxes. Detectors are considered for three neutron energy ranges: thermal, resonance (energies from ~0.4 ev to ~100 kev), and fast. (N.W.R.)

18318 IMPROVEMENTS IN OR RELATING TO PHASE-SENSITIVE ELECTRIC CIRCUIT ARRANGEMENTS INCLUDING RELAYS. Donald Harrison and Raymond John Cox (to United Kingdom Atomic Energy Authority). British Patent 865,643. Apr. 19, 1961.

A circuit arrangement for controlling a relay according to the phase of an a-c signal is described and shown. The circuit is comprised of a relay having a centrally pivoted armature made up of two parallel members and two magnetic circuits, each including an electromagnet. A pole of one electromagnetic is located between the members at each end of the armature, and a pole of the other electromagnetic is located outside the members, midway between the ends of the armature. An a-c signal source is connected to energize one electromagnet and an a-c reference source of the same frequency is connected to energize the other electromagnet. (N.W.R.)

18319 AN IMPROVED METHOD AND DEVICE FOR MEASURING DOSES OF THERMAL NEUTRONS. (to Commissariat à l'Energie Atomique). British Patent 866,122. Apr. 26, 1961.

Methods of neutron dosimetry are described. Thin plates containing B^{10} , Li^6 , or other suitable nuclei are shielded on one side, so that the thermal neutron flux is anisotropic. The deformation or stress in these plates caused by changes in atomic structure is measured to determine the dose. Alternatively the fast ions produced by neutron reactions on these nuclei may be used to deform a second plate, and the dose measured as before. Three cylindrical rods may be connected to form a trirectangular trihedral; the deformation of this configuration gives the vectorial properties of the flux. (T.F.H.)

18320 IMPROVEMENTS RELATING TO FLUX SCANNING EQUIPMENT FOR NUCLEAR REACTORS. Max William Jervis (to A.E.I.-John Thompson Nuclear Energy Co., Ltd.). British Patent 866,514. Apr. 26, 1961.

An apparatus for determining the neutron flux density distribution in the core of a nuclear reactor is described. The apparatus consists of a wire which may be lowered and raised into a vertical core passage. The intensity of radiation obtained from the wire is measured from the device taking into account the duration of the period for various parts of the wire in the reactor core. This is done by

passing the wire adjacent to an ionization chamber from which a signal, determined by the distance along the wire, is subtracted from the output from the ionization chamber prior to passing the output to a measuring apparatus. (N.W.R.)

18321 CAPACITY—OPERATED PROTECTIVE SYSTEM. (to U. S. Atomic Energy Commission). British Patent 867,136. May 3, 1961.

A system for protecting a security area from intruders is described. The system is comprised of a sensing capacitor having first and second plates disposed in the security area. The detector is comprised of a transistor two-stage astable multivibrator with rectifier means for producing a proportional d-c output signal. The system also contains a monitor disposed at a location removed from the security area that responds to only sudden changes in input signal and thereby actuates an alarm device. Lines connect the output signal of the rectifier to the monitor input and the first sensing capacitor plate to the collector of one stage of the multivibrator, the second sensing capacitor plate being directly connected to the base of the other stage. The first sensing capacitor plate is at ground potential and the connection to the detector through the line is made by a ground connection at the monitor. (N.W.R.)

18322 IMPROVEMENTS RELATING TO BEAM DEFINING APPARATUS. Walter John McKelliget (to Associated Electrical Industries, Ltd.). British Patent 867,240. May 3, 1961.

An apparatus for defining the cross section of a beam of penetrating radiation, particularly x or gamma rays, from a high-intensity source is described. The apparatus consists of a mass of radiation absorbing material adapted to surround a source of high-intensity radiation and of such thickness as to reduce the intensity transmitted to a required level. There is an aperture through which a beam of radiation may pass and three pairs of blocks to define the width of the beam in two substantially perpendicular directions. (N.W.R.)

18323 IMPROVEMENTS IN OR RELATING TO APPARATUS FOR DETECTING THE PRESENCE OF RADIOACTIVE PARTICLES IN A GAS STREAM. Everett Long, Gordon Packman, and John Raymond Gurner (to Plessey Co., Ltd.). British Patent 867,368. May 3, 1961.

A detector is designed for detecting the presence in a gas stream of radioactive particles which can be collected on a solid surface under the influence of an electric field. The principal application of the detector is in monitoring coolant gas passing through a reactor in order to detect fuel element failure. The detector consists of a pressure tight vessel having inside a precipitation chamber and a radiation detector, a wire or tape extending through the precipitation chamber and through or past the detector. Means are provided for removing the wire from the chamber to the detector and for feeding gas through the chamber. (N.W.R.)

18324 IMPROVEMENTS IN OR RELATING TO APPARATUS FOR DETECTING RADIOACTIVE PARTICLE EMISSION. Dennis James Skillings (to United Kingdom Atomic Energy Authority). British Patent 867,369. May 3, 1961.

A modification of a beta detector is discussed. The apparatus detects radioactive particle emission from a wire or tape inside a vessel adapted to be pressurized. The apparatus consists of a scintillation-emitting, particle sensitive phosphor shaped to embrace the wire inside the vessel and a scintillation guide penetrating and sealed in the wall of the vessel for transmitting scintillations through the wall. The inside of the phosphor is lined with a material having a beta particle absorption characteristic such that it is capable of transmitting a measurable fraction of beta particles from decaying fission products while absorbing substantially all beta particles derived from Ar^{41} . The device is suitable for monitoring coolant gas passing through a nuclear reactor. (N.W.R.)

Materials Testing

18325 (TID-12680) ANNUAL REPORT AND TECHNICAL PROPOSAL FOR CONTINUATION OF WORK RELATING TO A STUDY OF X-RAY EFFECTS CAUSED BY POINT DEFECTS IN METALS. (Franklin Inst. Labs. for Research and Development, Philadelphia). May 9, 1961. Contract AT(30-1)-2585. 25p.

An investigation is described in which known numbers of interstitial atoms are introduced into a host lattice for observations concerning x ray diffraction pattern changes. Most of the work so far was devoted to the Ti-O system. It was tentatively concluded that the theoretical estimate of x ray intensity reduction may be viewed as a prediction that the effect is small and might not be observable with the present techniques. (J.R.D.)

18326 (TID-12717) PHOTOTHERMOELASTIC INVESTIGATION OF RECTANGULAR PLATES. Angelo Colao and Herbert Becker (New York Univ., New York. Coll. of Engineering). Dec. 1960. For General Electric Co. Contracts AT(11-1)-171 and AF33(600)-38062. 30p. (XDC-61-2-118)

High precision photothermoelastic experiments were conducted to determine the thermal stresses generated at the edge centers of rectangular plates of different proportions with a controlled parabolic temperature distribution applied in one direction. The results were compared with the predictions of theoretical approaches to this problem. A detailed description of the program is presented together with experimental and theoretical data. (auth)

18327 SOME DISCRETE DISTRIBUTIONS ASSOCIATED WITH LIFE TESTING. J. G. Magistad (Sandia Corp., Albuquerque, N. Mex.). 11p. of "Proceedings of Seventh National Symposium on Reliability and Quality Control." (SCR-273)

Methods are described for measuring the lifetime of a device in terms of the number of cycles the device performs before failure. Three distributions, geometric, negative binomial (Pascal), and cycle dependent geometric are compared. Statistical properties of these methods are discussed; it is shown that the methods reduce to continuous statistical functions (the exponential, gamma, and Weibull functions, respectively) for continuous operation. (T.F.H.)

GEOLOGY, MINERALOGY, AND METEOROLOGY

18328 (A/AC.82/G/L.542(Add.1)) LA RETOMBEE RADIOACTIVE A MOL ET AU CONGO. RAPPORT D'AVANCEMENT DU DEUXIEME SEMESTRE 1959. (Radioactive Fall-Out at Mol and in the Congo: Advance Report for the Second Half of 1959). E. Van der Stricht, R. Vaninbrouckx, M. De Visscher, and M. Dandoy (Brussels. Centre d'Etude de l'Énergie Nucléaire). May 1960. 60p.

The results of measurements of fall-out at Mol and in the Belgian Congo are given for July to December 1959. The air activity, total fall-out, and determinations of Sr^{90} , Sr^{89} , and Cs^{137} are tabulated. Meteorological data are also given. (J.S.R.)

18329 (APRL-38-3.2) DYNAMIC ROCK MECHANICS INVESTIGATIONS FINAL REPORT, PROJECT COWBOY. Harry R. Nicholls, Verne Hooker, and Wilbur I. Duvall (Bureau of Mines. Applied Physics Research Lab., College Park, Md.). Sept. 1, 1960. Contract AT(29-2)-914. 57p.

Strain gage instrumentation is reported of three Cowboy shots to measure the strain produced in salt by coupled and decoupled detonations. Linear array tests were made to develop a propagation law for strain, to determine particle velocity and acceleration in salt, to compare explosives, to determine the effect of impedance coupling between explosive and rock, and to investigate other seismic effects. Crater tests were made to determine the dynamic tensile breaking strength of salt. Tests were made to measure *in situ*, longitudinal (P) and shear (S) wave velocities and to calculate the dynamic elastic constants therefrom. Laboratory tests on core were made to determine the dynamic compressive and tensile breaking strength of salt. Physical properties tests were made under laboratory conditions for comparison with dynamic results. (W.L.H.)

18330 (BNL-635) A STUDY OF THE WIND PROFILE IN THE LOWEST 400 FEET OF THE ATMOSPHERE. Progress Report No. 7, May 16, 1960–September 15, 1960. Irving A. Singer and Constance M. Nagle (Brookhaven National Lab., Upton, N. Y.). Sept. 1960. 20p. Contract R-65-8-99812 SC-04-91.

A discussion is given of the testing of the predictability of wind speed from the wind speed at a lower reference level, using an unweighted predictor of varying average length and relative displacement in time. Two models were tested and compared to the "best possible" linear predictor: the simple model and the mean model. Four different gustiness conditions were analyzed to show the effects of lagging the reference level by 0, 30, 60, 90, and 120 sec and increasing its averaging length by factors of 1, 2, and 4. The predicted averaging lengths studied were 3, 12, 30, 60, and 180 sec. It is assumed in using the predictor models that the average wind speeds are known or can be estimated. The ability to predict the hourly average wind speeds at 355 ft from the 37-ft level for a 2-mo period, using a power law relationship, was tested, and the preliminary results are presented. (auth)

18331 (FFIP-IR-F-412) SEASONAL AND LATITUDINAL VARIATIONS IN RADIOACTIVE FALLOUT. T. Hvin-den, A. Lillegraven, and O. Lillesaeter (Norway. Forsvarets Forskningsinstitut, Kjeller). Jan. 1961. 13p.

Seasonal and latitudinal variations in fall-out appear to be closely related to variations in precipitation. Therefore, such variations in fall-out may not be entirely due to variations in air exchange between the stratosphere and troposphere. (auth)

18332 (IA-572) RADIOACTIVE FALLOUT IN ISRAEL. PART 2. STRONTIUM-90 IN RAINWATER AND SOILS. J. R. Gat (Gutmann) and J. Gilat (Israel. Atomic Energy Establishment, Rehovoth). Dec. 1960. 39p.

Submitted as a Thesis by J. Gilat to Hebrew Univ. Sr^{90} measurements in rain water and soils in Israel during the period October 1957 to May 1959 are reported. Sampling and analytical procedures are described and local factors influencing the Sr^{90} distribution in soil discussed. (auth)

18333 (NP-9540) MONTHLY REPORT, DEVELOPMENT, OCTOBER, 1960. (Eldorado Mining and Refining Ltd. Research and Development Div., Ottawa). 21p. (D-60-10).

Standard atmospheric leach tests were made on August mill head samples and on low-sulfur flotation tails prepared from these. Data obtained in these tests are included along with data obtained in carbonate leach tests on Back Bay ore. Other data on precipitation of vanadium with uranium and from carbonate with iron additives are tabulated. In metal development, 50 wt.% U-Fe alloys were prepared by direct induction melting, and oxide reductions of oxide systems by heating under inert gases are reported. Sintered Part Hope UO_2 pellets with densities of 10.40 to 10.62 g/cc showed twinning at the highest density while the lower density pellets displayed fairly equiaxed grains. (J.R.D.)

18334 (NP-10108) A STUDY ON AIR POLLUTION. DIFFUSION AND SAMPLING (thesis). Louis Adolf Clarenburg (Utrecht. Rijksuniversiteit). 1960. 89p.

A diffusion equation is presented for an instantaneously created gas cloud, starting from the Newtonian equation of motion of a particle in turbulent air and from the equation of continuity. A derivation based on the principles outlined by Schmidt is demonstrated on a theoretical model and a comparison is made with Sutton's results on the same model. The effect of large eddies on diffusion is considered. A theory is presented for use in the sampling of gases and of particles from turbulent streaming air. Factors affecting sampling precision are discussed. Results of experiments are included which support the theories developed. Empirical relations are given between the turbulent diffusion parameters occurring in the diffusion equations and some easily measurable meteorological quantities. (C.H.)

18335 (NSEC-30) EVALUATION OF RADIOACTIVE FALLOUT. Final Report, July 1, 1959 to June 30, 1960. Leonard P. Salter (Nuclear Science and Engineering Corp., Pittsburgh). Sept. 30, 1960. Contract AT(30-1)-2420. 38p.

A study was made of the fallout pattern during a rainfall that occurred during the period January 12 to 13, 1960 in the Pittsburg area. The samples were analyzed for Sr^{90} , Ce^{144} , and gross β activity. A change of Sr^{90} activity concentration of about 100 was observed during the course of the storm. A sharp decrease in concentration apparently occurred with the increase in rainfall intensity. The concentrations of gross β activity and Ce^{144} appeared to follow the same pattern. Predictions of trends in rainfall activity, observed at the ground, were made from the experience of air masses over Pittsburg and compared with the measured activity level. An evaluation was made of the Ce^{144} to Sr^{90} ratio in nuclear debris and fallout. Values of the ratio, R_p , for 1959 Ash Can upper air samples from 42°N at altitudes of 65,000, 80,000, and 90,000 ft. are shown. Results indicated that fractionation of Ce^{144} and Sr^{90} in the stratosphere is

not significant. Material at 65,000 ft. was representative of debris about $\frac{3}{4}$ yr. older than material at 90,000 ft. Vertical mixing in the stratosphere at this level was found to be slow. The Ce^{144} to Sr^{90} ratio was also determined in Pittsburgh rainwater. (M.C.G.)

18336 (TID-4900) RARE EARTHS AND MONAZITE SANDS. A List of Selected References to Technical Reports, Books and Journals. Francis L. Sachs, comp. (Office of Technical Information Extension, AEC). Mar. 30, 1961. 6p.

A list of 56 references on rare earths and monazite sands is presented. These references include technical reports prepared by the AEC, its contractors, and other government agencies and items from the published literature. (M.C.G.)

18337 (TID-11863) HELIUM AND ARGON IN ROCKS AND MINERALS. Annual Progress Report No. 6. J. Lawrence Kulp, L. E. Long, F. D. Eckelmann, G. P. Erickson, F. P. Fanale, J. C. Engels, and R. Kologrivov (Columbia Univ. Palisades, N. Y. Lamont Geological Observatory. Geochemical Lab.). Feb. 15, 1961. Contract AT(30-1)-1669. 100p.

Determinations of the quantity of radiogenic argon in rock and minerals are described. Studies in the Southern Appalachians metamorphic complex were continued to obtain information on the effect of multiple metamorphic events in a single region. The ages of the metamorphic belts were observed on micas from mignatite, polymetamorphic granites, and unmetamorphosed granites. Whole rock K-Ar ages from Hudson River pelite west of the metamorphosed zone indicated that conditions of isoclinal folding alone were sufficient to drive out pre-existing argon from old detrital minerals. A comprehensive review of the geological time scale was made. The argon and potassium isotope dilution techniques were subject to continuing study. Additional experiments were conducted on the helium content of carbonate rocks. Results indicated that the helium method is not a practical geochronometer for carbonates. Work was continued on the use of the K-Ar method on basaltic rocks. The first ocean floor basaltic rocks were analyzed and indicated recent formation. Experimental studies were continued on radioactive tracers in base exchange processes to simulate the effects of ground waters on the K-Ar and Rb-Sr ages in biotites. The helium, uranium, and thorium contents of Triassic magnetite crystals were determined. Investigations of the possible utilization of hornblende as a mineral for K-Ar dating were carried out. It appeared that small clean single crystals of hornblende may give excellent age results. The age of the basement rocks of the East Greenland Geosyncline was determined. Preliminary work on the usefulness of glauconite, sylvite, and illite in dating the salt deposits of the Persian Gulf suggested that useful minimum dates can be obtained and that mobile salt may give the age of the last movement. The international calibration program was continued. (M.C.G.)

18338 (TID-12624) STRATOSPHERIC AEROSOL STUDIES BY AIRCRAFT. C. E. Junge and J. E. Manson (Air Force Cambridge Research Labs., Bedford, Mass.). [1961]. Contract AT(49-7)-1431. 69p.

The stratospheric aerosol layer previously identified by balloon measurements was studied extensively by means of recovered rod impactor samples obtained from aircraft flights at the 20 km level from 63°S to 72°N during March to November, 1960. From a variety of physical and chemical measurements, which are presented in detail, the conclusion was drawn that this layer is stable, constant in

time and space, and is composed mainly of sulfate particles. The various questions raised by this result, particularly with respect to collection of micrometeorites, are presented and discussed. (auth)

18339 (TID-12625) THE VERTICAL DISTRIBUTION OF SUB-MICRON PARTICLES IN THE STRATOSPHERE. Charles W. Chagnon and Christian E. Junge (Air Force Cambridge Research Labs., Bedford, Mass.). Jan. 1961. Contract AT(49-7)-1431. 30p.

The vertical distribution of stratospheric particles with an average radius of 0.15μ is presented in the form of five vertical profiles. These show a broad maximum in numerical concentration between 16 and 23 km, and are remarkably consistent throughout the one-year period of observations from November 1959 to October 1960. It is suggested that this "aerosol layer" is identical to the particles responsible for the "purple light" phenomenon, and the haze layers observed in the stratosphere. Some pertinent details of the balloon-borne collection instruments are included. (auth)

18340 (TID-12635) THERMOLUMINESCENCE AND THE GEOCHEMISTRY OF CALCIUM CARBONATE IN RELATION TO RADIOACTIVE IMPURITY CONTENT. Technical Progress Report, June 1, 1960 to April 1, 1961. (Kansas. Univ., Lawrence). Includes Reprint: THE EFFECT OF STRONTIUM ON THE ARAGONITE-CALCITE RATIOS OF PLEISTOCENE CORALS. Frederic R. Siegel. J. Sedimentary Petrol., 30: 297-304 (June 1960). Contract AT(11-1)-83. 18p.

The effects of nonhydrostatic pressures on natural radiation-damage thermoluminescence were studied and ratios between pressure-produced and natural radiation-damage thermoluminescence were calculated. Results indicated that the effects of pressure are marginal and introduce no serious errors into geologic age determinations based on thermoluminescence. A reevaluation of the geologic age of the Silver City Intrusive, Woodson County, Kansas as determined by thermoluminescence was completed. The conditions for the precipitation of dolomitic carbonate were investigated and altered to more nearly approach those of a normal sedimentary environment. The factor which appeared to be most important in controlling the formation of dolomite was the rate of reaction. A historical résumé of theoretical research into the effects of pressure on the thermoluminescence of some rocks and minerals is presented. Of several mineral samples studied, only four (amblygonite, orthoclase, pectolite, and scapolite) displayed an appreciable amount of natural thermoluminescence. In a study of the Pleistocene coral reefs, a quantitative relation between the strontium content of the corals and their aragonite-calcite ratios was found. In samples with distinct areas of aragonite and calcite, the aragonite portion contained about twice as much strontium as the calcite. (M.C.G.)

18341 (CEA-tr-A-834) TENEUR EN Sr^{90} DE QUELQUES SOLS DU SCHLESWIG-HOLSTEIN. (Sr^{90} Content of Some Soils of Schleswig-Holstein). E. Knoop and D. Schroeder. Translated into French from Naturwissenschaften, 45: 436-7 (1958). 5p.

Measurements were made on the Sr^{90} content of Schleswig-Holstein soil at various sites and at different depths from 0 to 15 cm. The mean monthly quantity of rain in mm and the activity of Sr^{90} in $10^{-9} \mu\text{C/g}$ were determined. The results are tabulated. (J.S.R.)

18342 (CEA-tr-R-274) VALEURS DES SOURCES SOUTERRAINES D'APPROVISIONNEMENT EN EAU LORS DE LA CONTAMINATION DES TERRAINS PER DES PRODUITS RADIOACTIFS PROVENANT DE LA FISSION DE

L'URANIUM. (Value of Subterranean Sources for Water Supply During Contamination of the Terrain by Radioactive Products from Uranium Fission). A. S. Belstskii. Translated from *Gigiena i Sanit.*, 23: No. 10, 23-7(1958). 12p.

The contamination of subterranean water sources is studied by considering contamination from the surface only and by direct introduction of radioactive substances in the aquiferous horizons. The difficulties in measuring subterranean contamination are discussed. The coefficients of filtration of different types of rocks were determined. (J.S.R.)

18343 USE OF THE ELECTRON MICROSCOPE IN THE IDENTIFICATION OF THE CONSTITUENT MINERALS OF GUMMITES. A. Arribas and F. Catalina (Junta de Energia Nuclear, Madrid). *Anales real soc. espan. fis. y quim* (Madrid), Ser. A., 56: 237-42(Sept.-Oct. 1960). (In Spanish)

A method to identify the U minerals of gummities is described. Gummities were studied by x-ray, optical, and chemical methods. The results of electron microscopic studies are presented. (auth)

18344 OBSERVATIONS ON THE BEHAVIOR OF FISSION PRODUCTS IN SURFACE WATERS. K. Liebscher, F. Habashi, and T. Schönfeld (Universität, Vienna). *Atompraxis*, 7: 94-100(Mar. 1961). (In German)

Fission product contents of surface waters and other water samples (rain, spring, and tap water) were determined by gamma spectrometry of evaporation residues from autumn 1958 until summer 1959. The results permitted assumptions on the behavior of fission product Zr, Nb, Ru, and Ce which had entered the water through fall-out. It was found that the residence time of these products in the water is relatively short. Decontamination through settling or through adsorption on suspended mineral probably plays an important role. Ru, however, shows a long residence time in comparison with the other fission products. This is attributed to the tendency of Ru to be dissolved out of fall-out particles and to form an anionic species which, because of its negative charge, is not adsorbed. These assumptions were confirmed by observations on the behavior of radoruthenium in the penetration of water through strata of rocks or through water treatment plants and sand beds. The importance of settling in the removal of fission products was also confirmed by laboratory experiments. (auth)

18345 SURVEY OF THE RADIOACTIVITY FROM FALL-OUT IN GEOGRAPHIC WATER, IN RAIN WATER, AND IN MILK SAMPLES. M. Cadeddu and R. Canazi (SADE, Venezia, Italy). *Energia nucleare* (Milan), 8: 178-87(Mar. 1961). (In Italian)

Data on fall-out radioactivity in rain water, geographical water, and milk samples, collected in Veneto by the Nuclear Department of Società Adriatica di Elettricità from July 1959 to July 1960 are reported. The survey was carried out in order to obtain some information about the present level of fission product radioactivity as well as to test different techniques suitable for an aerial survey program. (auth)

18346 THE GEOCHEMISTRY OF COBALT. M. H. Carr and K. K. Turekian (Yale Univ., New Haven). *Geochim. et Cosmochim. Acta*, 23: 9-60(Apr. 1961). (In English)

Neutron activation was used to analyse standards for the emission spectrograph and materials low in cobalt. During differentiation of a basaltic magma most of the cobalt enters the ferromagnesian minerals. The cobalt content of these minerals depends on the total number of Fe-Mg lattice sites and is independent of the Fe/Mg ratio. This relationship appears to hold for basaltic rocks in general. Cobalt is strongly coherent with magnesium in granitic rocks and

behaves like magnesium in its partition relations between metamorphic minerals. The acceptance of both cobalt and magnesium is more selective at lower grades of metamorphism. These observed coherence relations require a re-evaluation of the geochemical laws governing the distribution of trace elements in the petrogenesis of igneous and metamorphic rocks and the partition of trace elements between coexisting minerals. In sediments most of the cobalt is in the argillaceous fraction and seems to follow iron and manganese. The cobalt economy in the deep sea is discussed and we conclude that with present knowledge, the cobalt accumulations in deep-sea sediments may be explained as the result of supply of detritally associated cobalt and dissolved cobalt from surface runoff rather than volcanic exhalations. The crustal abundance of cobalt is calculated as 27 ppm on the model of a crust of basalt and granodiorite in equal proportions. (auth)

18347 THE RELATION OF DISCORDANT Rb-Sr MINERAL AND WHOLE ROCK AGES IN AN IGNEOUS ROCK TO ITS TIME OF CRYSTALLIZATION AND TO THE TIME OF SUBSEQUENT Sr^{87} - Sr^{86} METAMORPHISM. H. W. Fairbairn, P. M. Hurley, and W. H. Pinson (Massachusetts Inst. of Tech., Cambridge). *Geochim. et Cosmochim. Acta*, 23: 135-44(Apr. 1961). (In English)

Interpretation of discordant Rb-Sr ages of coexisting biotite and K-feldspar in igneous rocks, mostly from Sudbury, Ontario, is attempted using supplementary whole-rock ages. It is postulated that, if the igneous body is a closed system, and a post-crystallization thermal event interrupts the accumulation of Sr^{87} in biotite and K-feldspar, the whole-rock analysis will give the true age and, owing to diffusion of radiogenic Sr out of biotite and K-feldspar, the apparent ages of these two minerals would be less than the whole-rock age. The common intersection of the three radiogenic growth lines ($\text{Sr}^{87}/\text{Sr}^{86}$ plotted against age) gives the time of metamorphism. For the majority of the twelve examples the model offers an apparently valid explanation of the discrepant ages in terms of known field relations and two orogenic events at 1.2 billion years and 1.6 billion years. (auth)

18348 ABSOLUTE RATIO OF $\text{B}^{11}/\text{B}^{10}$ IN SEARLES LAKE BORAX. C. C. McMullen, C. B. Cragg, and H. G. Thode (McMaster Univ., Hamilton, Ont.). *Geochim. et Cosmochim. Acta*, 23: 147-50(Apr. 1961). (In English)

Mass spectrometric analyses of Searles Lake, California, borax were carried out in a multiple-filament high-sensitivity mass spectrometer employing an electron multiplier detector followed by an electrometer current integrating circuit. The isotopic ratios obtained permitted an evaluation of the mass discrimination of the instrument at masses 88 and 89, which were the major ion currents observed (Na_2BO_2^+). The abundance ratios yielded absolute $\text{B}^{11}/\text{B}^{10}$ ratios from 4.040 to 4.072. (N.W.R.)

18349 THE GEOCHEMISTRY OF THE STABLE ISOTOPES OF CHLORINE. T. C. Hoering and P. L. Parker (Univ. of Arkansas, Fayetteville). *Geochim. et Cosmochim. Acta*, 23: 186-99(May 1961). (In English)

A procedure for measuring small differences in Cl^{37} - Cl^{35} ratios was developed. It was tested by measuring the chlorine isotope fractionation in the following isotopic exchange reactions: (a) ammonium chloride, hydrogen chloride; (b) solid sodium chloride, aqueous chloride ion; (c) chlorine, hydrogen chloride; (d) aqueous hexachloroplatinate (IV), chloride ion. The Cl^{37} - Cl^{35} ratio in eighty-one samples of natural occurrence was investigated. No significant variations in the ratio were observed. The results are discussed in terms of the geochemical cycle of chlorine. (auth)

18350 VALUES FOR TRACE ELEMENTS IN G-1 AND W-1 WITH NEUTRON ACTIVATION ANALYSIS. Hiroshi Hamaguchi, Kenji Tomura, Kenju Watanabe, Tsutomu Yasunaga, Tadashi Endo, Rokuro Kuroda, Masumi Osawa, Naoki Onuma, and Kyoichi Hosohara (Tokyo Univ. of Education). *Geochim. et Cosmochim. Acta*, 23: 296-9 (May 1961).

Trace elements were determined in Japanese granite (G-1) and basaltic (W-1) rocks by neutron activation analysis. The elements determined are antimony, arsenic, copper, europium, gold, lanthanum, samarium, scandium, and uranium. The results are compared with previous determinations. (N.W.R.)

18351 ANOMALOUS LEADS FROM BROKEN HILL, AUSTRALIA. R. D. Russell, T. J. Ulrych, and F. Kollar (Univ. of British Columbia, Vancouver, Can.). *J. Geophys. Research*, 66: 1495-8 (May 1961).

Results are presented from isotopic analyses of seven Thackaringa-type leads from Broken Hill, Australia, occurring in vein-type deposits. The points representing these leads lie, within very narrow limits, along a straight line on a Pb^{207}/Pb^{204} versus Pb^{206}/Pb^{204} plot. This graph proves, beyond serious doubt, the contention made in a previous paper in 1957, that the Thackaringa-type leads at Broken Hill are a series of anomalous leads. The isotopic analyses are interpreted to indicate that the Thackaringa-type leads were deposited at a time not earlier than 1190 ± 35 million years ago and that the source material for the anomalous radiogenic lead component came into existence not before 1970 ± 50 million years ago but not later than 1190 ± 50 million years ago. Approximate values for the thorium-uranium ratios of the anomalous lead sources are included. (auth)

18352 Rb-Sr AGE MEASUREMENTS ON TOTAL ROCK AND SEPARATED-MINERAL FRACTIONS FROM THE OLD GRANITE OF THE CENTRAL TRANSVAAL. H. L. Allsopp (Bernard Price Inst. of Geophysical Research, Johannesburg). *J. Geophys. Research*, 66: 1499-1508 (May 1961).

The ages here reported relate to the Old Granite exposed between Johannesburg and Pretoria in the Transvaal. The Rb-Sr method was used to measure the ages of five total-rock samples and thirteen mineral fractions separated from the granite and from pegmatite veins. The chemical and mass-spectrometric techniques employed are described briefly. The total-rock samples yield concordant results, and the age of emplacement of the granite is found to be 3200 ± 65 My ($\lambda = 1.39 \times 10^{-11}$ years $^{-1}$), while the primary abundance of Si^{87} is found to be 0.07006 ± 0.00030 . The apparent ages as deduced from the separated minerals vary widely, and ages both higher and lower than the total-rock age are reported. It is considered that the discordance of the mineral ages is the result of the diffusion of radiogenic strontium from mineral to mineral and that the diffusion probably occurred about 2000 My ago. (auth)

18353 SPACE EROSION OF THE GRANT METEORITE. David E. Fisher (Cornell Univ., Ithaca, N. Y.). *J. Geophys. Research*, 66: 1509-11 (May 1961).

An upper limit to the erosion of iron meteorites in space is calculated, based on the cosmic exposure age of the Grant meteorite and the measured depth variation of cosmogenic Ne^{21} in this meteorite. A value for E_{max} of $\sim 1.1 \times 10^{-8}$ cm/yr is found. A previous estimate based on the Sikhote-Alin meteorite is discussed. (auth)

18354 COSMOGENIC ARGON AND NEON IN STONE METEORITES. Heinz Stauffer (Univ. of California, La Jolla). *J. Geophys. Research*, 66: 1513-21 (May 1961).

The abundance and isotopic composition of argon and

neon in six chondrites and an achondrite were measured. The results of previous investigations are confirmed, namely Ar/K ages from 1.3 to 4.6 billion years and exposure ages from 4 to 24 million years. It is shown that the differences of the ratios Ar^{36}/Ar^{38} are due mainly to small amounts of trapped primordial or atmospheric argon. Using the corrected Ar^{38} abundances, a value of 9.0 with a total spread of ± 20 per cent is found for the corrected Ne^{21}/Ar^{38} ratios. The possibility of diffusive losses of cosmogenic rare gases is discussed. (auth)

18355 MEASUREMENT OF POSITIVE-ION DENSITY IN THE IONOSPHERE BY SOUNDING ROCKET. T. Ichimiya (Electrical Communication Lab., Tokyo), K. Takayama, T. Dote, Y. Aono, K. Hirao, S. Miyazaki, T. Sugiyama, and T. Muraoka. *Nature*, 190: 156-8 (Apr. 8, 1961).

Two sounding rockets, provided with spherical Langmuir probes in the nose cone, were used to measure positive ion density in the ionosphere. Data are presented graphically and comparisons are made of the data taken in the daytime and at night during ascents and descents. (C.H.)

18356 SOIL STRIPPING FOR REMOVAL OF STRONTIUM-90. J. A. Schufle (New Mexico Inst. of Mining and Technology, Socorro). *Texas J. Sci.*, 13: No. 1, 3-6 (Mar. 1961).

Consideration is given to the problem of Sr^{90} removal from soil. This leads to the suggestion that one of the cheapest ways of removing strontium might be through the use of complexing agents in solution. (auth)

18357 THE GEOLOGICAL TIME SCALE. J. L. Kulp. p.18-27 of "Report of the International Geological Congress, XXI Session, Norden, 1960, Copenhagen. Part III. Pre-Quaternary Absolute Age Determination." (In English)

New isotopic age determinations on rocks with reasonably well defined stratigraphic position permit a refinement of the time scale from the Cambrian to the Recent. The entire history of the earth may be placed on a more quantitative basis. The key points in the scale are discussed in some detail from new isotopic measurements using the K-Ar, Rb-Sr, and U(Th)-Pb methods. Some of these include Wichita Mts., Okla. (Cambrian), Nova Scotia and English granites (Devonian), Vosges and French Central Massif granites (Lower Carboniferous), Southwest England granites (Top Carboniferous), Palisades N. J. sill (Upper Triassic), Sierra Nevada and Coast Range granites (Jurassic and Cretaceous), and various Tertiary extrusives. The problem of the age of the Swedish kolm is also discussed. Pre-Cambrian age measurements are evaluated in terms of major orogenic cycles and the concepts of continental growth and worldwide synchronicity of the larger scale events. These considerations lead to a revised geological time scale. (auth)

18358 PRELIMINARY GEOLOGIC MAP OF THE NORTHWEST QUARTER OF THE BOULDER QUADRANGLE, MONTANA. George E. Becraft and Darrell M. Pickney (Geological Survey, Washington, D. C.). Mineral Investigations Field Studies Map MF-183. 1961.

18359 STRATIGRAPHY AND STRUCTURE OF THE HOUSE ROCK VALLEY AREA, COCONINO COUNTY, ARIZONA. John D. Wells (Geological Survey, Washington, D. C.). Geological Survey Bulletin 1081-D. 1960. 44p., 2 illus.

The House Rock Valley area consists of four 7.5-minute quadrangles that cover House Rock Valley, part of the Paria Plateau, part of the East Kaibab monocline, and part of the Kaibab Plateau. The bedrock in the area consists of red siltstone in the Hermit shale, gypsum in

the Toroweap formation, and dolomite, limestone, and sandstone in the Toroweap formation and Kaibab limestone, all of Permian age; red siltstone and sandstone in the Moenkopi and Chinle formations of Triassic age and in the Moenave formation of Triassic age, gray and red mudstone in the Chinle formation, and conglomeratic sandstone in the Shinarump member of the Chinle formation; red sandstone and siltstone in the Kayenta formation of Jurassic age and in the Carmel formation of Jurassic age, red and white eolian sandstone in the Navajo sandstone of Jurassic and Jurassic age, and red limestone in the Carmel formation. The Coconino sandstone is absent. The upper part of the Navajo sandstone and lower part of the Carmel formation are intertongued. In the Chinle formation the Shinarump member is thin in the northern part of the area and absent in the southern part; the Owl Rock member is thin or absent. All other units are typical of the rocks on the Colorado Plateau. Surficial Quaternary deposits are landslide blocks, landslide debris, sand, alluvial fans, and alluvium. The tectonic structures in this area are typical of those on the Colorado Plateau. The most prominent feature is the East Kaibab monocline, a 130-mile-long arcuate fold, which has the west side upthrown 3500 feet. Nearly parallel to the monocline are high-angle faults with offsets of several hundred feet; some have the east side upthrown, others have the west side upthrown. Many minor folds and faults trend nearly parallel to and diagonally to the monocline. Joints trend parallel to both the major and minor faults and folds. Some of the minor structures—shear zones and thrust faults—were formed by local compression while the high-angle faults, horsts, and grabens were formed by tension. No ore deposits are known to exist in the area although abnormally high radioactivity and copper

minerals are present. Small amounts of water occur at the base of the Navajo sandstone and in the unconsolidated surficial deposits. (auth)

18360 VANADIUM-URANIUM DEPOSITS OF THE RIFLE CREEK AREA, GARFIELD COUNTY, COLORADO. Richard P. Fischer. With a section on MINERALOGY. Theodore Botinelly (Geological Survey, Washington, D. C.). Geological Survey Bulletin 1101. 1960. 52p., 4 illus.

One of the largest vanadium-uranium deposits in the Colorado Plateau region is in the Navajo and Entrada sandstones in the Rifle Creek area. This deposit is well exposed by mine development and therefore suited to the study and interpretation of structural features, ore habits, and geochemical relations. Small deposits also occur in Morrison formation, but as they are poorly developed they have not been studied in detail. The geology of the region is discussed in detail. A map base comprising the triangulation net and the township survey is included. On it the horizontal positions of photo centers and additional points were established by radial-line plot from airphotos and planimetry between these control points was sketched from the airphotos. Many points of vertical control were then established by occupying with the planetable several locations recognizable on the airphotos, reading vertical angles to triangulation stations, and reading vertical angles to all nearby locations recognizable on the airphotos. The correct horizontal positions of the planetable stations and the locations shot from them were then transferred to the base map by the radial-line method. The elevations of the points occupied were then calculated. Contours were sketched between these points by stereoptic inspection of the airphotos. Geology was also transferred from airphotos by radial-line plot and inspection. (C.H.)

HEALTH AND SAFETY

18361 (A/AC.82/G/L.263) QUELQUES DONNEES RECENTES SUR LA CONVERSION ROENTGEN—RAD DANS L'OS ET LE MUSCLE. (Some Recent Data on Roentgen—Rad Conversion in Bone and Muscle). A. Astier and A. Allisy (Paris. Ecole Polytechnique). July 30, 1959. 15p.

The roentgen—rad conversion factors in bone and muscle were calculated from new data on the spectral distribution. The results obtained are compared with the values measured directly using the method of gas equivalents. These results are tabulated and graphed. (J.S.R.)

18362 (AE-44(2nd Rev.)) HAND MONITOR FOR SIMULTANEOUS MEASUREMENT OF ALPHA AND BETA CONTAMINATION. I. Ö. Andersson, J. Braun, and B. Söderlund (Aktiebolaget Atomenergi, Stockholm). Nov. 1960. 25p.

An instrument is described which measures α and β contamination of the hands simultaneously. This was achieved by using as detectors 8 flow counters paired in 4 units of two chambers, one unit for each side of the hand. The inner chamber of every unit (adjacent to the hands) delivers α -pulses, the outer chambers deliver β -pulses. When two finger contacts are pushed the detectors are closed around the hands and the measurement is started. Audible and visual warnings operate when the maximum permissible level is exceeded. Similar warnings operate if hands are removed before the end of the counting period. The activity levels are logarithmically indicated on four pointer instruments, which are automatically zeroed when the next measurement is started. The instrument is now commercially available. (auth)

18363 (AHSB(RP)-R-6) RECOMMENDED PRACTICE IN THE SAFE HANDLING OF PLUTONIUM IN LABORATORIES AND PLANTS. G. J. Appleton and H. J. Dunster (United Kingdom Atomic Energy Authority. Authority Health and Safety Branch. Radiological Protection Div., Harwell, Berks, England). Jan. 1961. 49p.

Plutonium, a by-product of nuclear reactor operation, is itself a fissile material and one of the most toxic of radioactive substances. Whenever the material is handled, consideration must be given to criticality implications, and the precautions generally required for radioactive materials must be applied stringently. A brief introduction to the physical, chemical, and toxic properties of plutonium, reviews the precautions to be taken in the design and operation of laboratories, plants and stores, and makes recommendations for safe practice. Criticality problems are discussed only in outline. (auth)

18364 (APAE-84(Add.1)) HAZARDS REPORT FOR THE SM-1 CORE II WITHOUT SPECIAL COMPONENTS. J. G. Gallagher (Alco Products, Inc., Schenectady, N. Y.). Apr. 19, 1961. Contract AT(30-1)-2639. 14p.

The changes incurred in the SM-1 by the insertion of the SM-1 Core II without special components are described. The SM-1 Core II components were made to specifications very nearly identical to those of SM-1 Core I. The differences consist of europium absorber sections, internal europium flux suppressors in the control rod fuel elements, and low impurity cladding. Each of the SM-1 Core II components with the exception of the five absorber sections in SM-1 Core I were subjected to a Zero Power Experiment at the Alco Critical Facility. The results of this experiment indicated that SM-1 Core II will have nuclear charac-

teristics very similar to that of SM-1 Core I. Since SM-1 Core II will be operated with the same mode of rod control, in the same core support structure, and with the same primary coolant flow conditions, the thermal characteristics should be essentially identical to that of SM-1 Core I. Also all kinetic characteristics of SM-1 Core II should be identical to those of SM-1 Core I. It was demonstrated that there is no increase in the potential for a hazardous situation at SM-1 due to the replacement of SM-1 Core I by SM-1 Core II. (auth)

18365 (ARCRL-4) STRONTIUM 90 IN MILK AND AGRICULTURAL MATERIALS IN THE UNITED KINGDOM, 1959-1960. Report No. 4. (Gt. Brit. Agricultural Research Council. Radiobiological Lab., Grove, Berks, England). 1961. 81p.

Data are tabulated on the quantity of Sr^{90} from worldwide fall-out present in the human diet in the United Kingdom during 1959. Results are included from a survey on Sr^{90} in milk from Jan. to June, 1960. Experimental studies are described which were designed to obtain more detailed information on factors which control the passage of Sr^{90} through the food chain. Data are tabulated from measurements of Sr^{90} in soil and on pastures after various treatments. 32 references. (C.H.)

18366 (GAMD-1700) REPORT TO REACTOR SAFEGUARDS COMMITTEE ON THE MGCR-4 FUEL IRRADIATION CAPSULE. Dale E. Johnson (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Sept. 21, 1960. Contract AT(04-3)-187. 52p. (MGCR-M-304)

An experiment was designed to provide data on the dimensional and structural stability and fission gas retention ability of MGCR prototype fuel pellets under conditions of reactor irradiation at surface temperatures in the range of 1500 to 1700°F and at surface heat fluxes of up to 250,000 Btu/hr-ft². The fuel material considered was composed of 30 volume % UO_2 dispersed as discrete particles in a matrix of BeO. The hazards involved in the irradiation include excess temperature, release of radioactive fission products, and leaks of gas or water. Descriptions of the capsule, the heat transfer mockup test results, instrumentation and control, hydraulics and heat transfer, capsule installation, and operation are given. (M.C.G.)

18367 (NP-10074) HAZARDS SUMMARY REPORT FOR THE KANSAS STATE UNIVERSITY TRIGA MARK II REACTOR. Special Report No. 7. R. W. Clack, J. R. Fagan, W. R. Kimel, and S. Z. Mikhail, comps. and eds. (Kansas State Univ., Manhattan. Engineering Experiment Station). Jan. 1961. 212p.

The Kansas State University TRIGA Mark II Reactor is rated at 100 kw. The core is located near the bottom of a pool, under ~16 ft of shielding water, and utilizes a solid, homogeneous fuel element in which the ZrH moderator is homogeneously combined with 20% enriched uranium. Descriptions are given of the facility, site, reactor usage, potential operating hazards, and potential external hazards. The operations manual is included to provide explicit operating procedures and rules, and to provide an operational guide to optimize security and maintenance of the reactor. The reactor administrative plans are outlined. Appendixes include: radiation safety manual; entry authorization, authorized entry, and emergency notification lists; and the Kansas State staff résumés. (B.O.G.)

18368 (NP-10125) GUIDE TO MEDICAL PLANNING FOR DISASTERS. (Strategic Air Command, Offut AFB, Neb.). Nov. 1960. 369p. (SACP-160-4)

Problems associated with disasters involving chemical, biological, or radiological warfare agents are outlined. Activities are discussed which are involved in medical planning for disaster, damage and casualty estimates in the event of nuclear attack, emergency medical treatment and casualty management, the handling of supplies, transportation, and communications, emergency sanitation, emergency medical facilities, and emergency blood procurement. Other topics discussed include medical and public health aspects of peacetime nuclear weapons incidents, the biological effects of radiation and the acute radiation syndrome, and the biological effects of tritium. Miscellaneous information appended includes a check list for planning actions, a list of disaster control equipment, tabulated reference data, methods for estimating casualties from nuclear weapons, a glossary, and bibliography. (C.H.)

18369 (NYO-4812) AIR CLEANING STUDIES. Progress Report for July 1, 1957 to June 30, 1958. Richard Dennis, Leslie Silverman, Edward Kristal, David M. Anderson, Charles E. Billings, Felix Stein, and Philip Drinker (Harvard Univ., Boston. Air Cleaning Lab.). Mar. 14, 1961. Contract AT(30-1)-841. 54p.

Mikro-Pulsaire Dust Collector Performance. The collector resistance of the Mikro-Pulsaire at 500 cfm was measured for fly ash and vaporized silica aerosols at various dust loadings, cleaning pressures, and pulse rates. The results indicate that relatively large loading variations do not cause extreme deviations in operating resistance, doubling the jet pressure gives a nearly fourfold reduction in the resistance, and doubling the pulse rate (except for vaporized silica) reduced the resistance by a factor of 1.5. For vaporized silica, the primary mechanism for dust dislodgement appears to be associated with the initial pressure impulse. Aerosol Filtration by Fixed and Fluidized Beds. The merits of charged granule beds are compared with those of non-charged beds. It was found that bipolar effects are an adjunct of collection efficiency only when the granule diameters exceed 0.4 mm and that the actual interstitial or jet velocity in granular media is several (up to 40) times greater than the face velocity. The impaction effect in granular fixed beds was determined and found to agree well with other work, and the effect of fluidizing velocity on the collection efficiency was studied for an uncharged polystyrene bed (50%-50% mixture of heated and unheated granules). An evaluation of charged polystyrene granule bed performance indicates that, relative to grounded media, net target efficiencies were increased fivefold and the air handling capacity was more than doubled for the same resistance to air flow. Incinerator Gas Cleaning Studies. A filter unit containing slag wool fiber in a 55-gallon drum was substituted for the glass filter bags in an incinerator and tested with burning sawdust charges. The results indicate that (1) lining of combustion chamber walls with fire brick gives improved combustion, (2) ratios of overfire to underfire air in the range of 1.5/1 to 1/1.5 do not affect the combustion products, (3) incinerators should be operated continuously, (4) slag wool fiber is satisfactory for particulate filtration at gas temperatures of 300 to 800°F, and (5) wet charges should be pre-dried or diluted with dry combustibles. NaK Fume Filtration. A filter unit composed of 3 and 6 denier bonded Dynel fiber was tested in the field. Other devices for NaK fume filtration are discussed. Blast Effects on Filter Systems. Damage to AEC absolute type filters was studied at the Nevada Test Site; field pressure

measurements were made on both sides of each collecting device. No observable physical damage occurred in AEC high-efficiency filters exposed to shock pressures of 1.6 psig or lower, whereas glass fiber roughing filters located normal to the direction of the approaching shock wave were completely destroyed at overpressures >1.5 psi. The results show that roughing or precleaning filters retain 20 to 60% of the dust blown off the high-efficiency collectors and that wire screen viscous filters may be a practical means of restricting dust re-entrainment. Filtration Studies. Preliminary test results on several types of synthetic fibrous media with aerosols are presented. Iodine Collection Studies. Several coated forms of 4- μ slag wool fibers were tested with respect to their collection efficiency for I^{127} ; Ag coatings were found to give the highest efficiency (99.9%) and lowest resistance. Tests with Sn and Cu ribbons and Zn granules indicate for Cu a high efficiency (99.99%) and a low resistance for iodine concentrations of 50 to 500 mg/m³. The tests made with Cu ribbons indicate that (1) iodine collection increases significantly at higher gas temperatures (300 to 350°C), (2) water vapor increases iodine collection efficiency, (3) Cu collectors once used at high temperatures are no longer functional at room temperature, and (4) service life at high temperatures is ~25 hr. Ag-plated Cu mesh was also studied; the efficiency at room temperature is slightly lower than for Cu alone but increases at 300°C. Over a test period of 100 hr at 300°C, collection efficiency remained above 99.6% with no apparent damage to the surface. The presence of H₂S or HNO₃ in the gas stream does not impair the efficiency. Water-Jet Scrubbers. The merits of water-jet scrubbers and Venturi scrubbers are compared. Collection efficiency measurements made on a Penberthy Hydraulic Ejector No. 67A with fly ash indicate that the hydraulic type ejector is not suitable for fume scrubbing applications. (D.L.C.)

18370 (NYO-9608) DEVELOPMENT OF INSTRUMENTS AND PROCEDURES FOR THE MORE ACCURATE DETERMINATION OF THE CUMULATIVE OCCUPATIONAL DOSE IN RADIOLOGY. Carl B. Brasestrup and Richard T. Mooney (Columbia Univ., New York and Francis Delafield Hospital, Physics Lab., New York). 1959. Contract AT(30-1)-2164. 17p.

A dual ionization chamber was developed for the accurate determination of exposure dose and simultaneous indication of radiation energy for the x-ray region. The outer chamber is energy independent and the inner is energy dependent. The change in charge of the chambers is determined on a specially constructed reader. Design features are described and applications as personnel monitors are discussed. (C.H.)

18371 (TID-12719) CRITICAL EXPERIMENT TANK (CET) REACTOR HAZARDS SUMMARY. N. J. Becar, J. F. Kunze, G. D. Pincok, and L. D. Van Vleck (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Mar. 31, 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 40p. (XDC-61-4-709)

The Critical Experiment Tank (CET) reactor assembly, the associated systems, and the Low Power Test Facility in which the reactor is to be operated are described. An evaluation and summary of the hazards associated with the operation of the CET reactor in the LPTF at the Idaho Test Station are also presented. (auth)

18372 (WT-727) AIR BLAST EFFECTS ON UNDERGROUND STRUCTURES. N. M. Newmark and G. K. Sinnamon (Illinois. Univ., Urbana). Project 3.8 [of] OPERATION UPSHOT-KNOTHOLE. Jan. 1954. Declassified Dec. 7, 1960. Contract DA-49-129-Eng-239. 138p.

Results are given from a test to determine the nature of

forces transmitted through earth to buried structures from an air burst. The structures were reinforced concrete boxes having a large number of simply supported steel beam strips forming their roofs. The structures were observed in two shots. No damage was observed in the first test. In the second shot, the pressures were of about the order of magnitude expected in the design, and the pressure wave had the expected highly irregular pulse-shape characteristic of the precursor region. Only small permanent deflections were obtained in the test, although the transient deflections were of an order of magnitude sufficient to give appreciable readings. Although the beams used in the structures had a higher yield point than originally planned, the general aims of the project were achieved. (auth)

18373 (YAEC-31(Suppl.2)) YANKEE CRITICAL EXPERIMENTS HAZARDS SUMMARY REPORT. P. W. Davison, D. Hunter, and J. Jedruch (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). July 1, 1958. For Yankee Atomic Electric Co. Contract AT(30-3)-222, Subcontract No. 1. 32p.

The hazards associated with the operation of the third of the series of Yankee critical experiments in which the water-to-uranium metal ratio is 4:1 are described. These experiments will be carried out in a core lattice which has more moderation than the 3:1 lattice; the temperature and void coefficients of the core remain negative but are smaller in absolute value. The energy released during the Maximum Credible Accident considered is lower than that given for the comparable incident considered in YAEC-31, provided advantage is taken of a weighted value of Doppler coefficient. It is concluded that the experiments to be performed on this critical experiment reactor do not increase the hazards to the public in the surrounding area beyond those hazards evaluated in YAEC-31. (D.L.C.)

18374 (CEA-tr-A-888) SIGNALISATION INTERNATIONALE DES RAYONNEMENTS ESSAIS DE NORMALISATION. (International Symbol for Radiation. Attempt at Standardization). Translated into French from Atomwirtschaft, 5: 235-8(1960). 11p.

The symbols and signs used in the last ten years by various national and international organizations to warn of radioactive areas are described. (J.S.R.)

18375 INDUSTRIAL HYGIENE TECHNIQUES IN THE DECONTAMINATION OF A BUILDING CONTAMINATED WITH RADIUM. Reynold L. Hoover (Combustion Engineering, Inc., Windsor, Conn.). Am. Ind. Hyg. Assoc. J., 22: 83-5(Apr. 1961).

Radium contamination had built up in a large office building over a period of forty years. The radiation levels were as high as 500 mrem/hr with alpha contamination $>40,000$ d/m/100 cm². From an industrial hygiene point of view, the major problems associated with the decontamination of the facility were: (1) keeping from tracking contamination into clean areas, (2) keeping the workers from becoming contaminated, (3) keeping the workers' exposure to external ionizing radiation as low as possible, (4) keeping inhalation and/or ingestion of radium from occurring, and (5) keeping future inhabitants of the building from receiving any radiation exposure. The building was decontaminated to a maximum of 0.2 mr/hr at a distance of one foot from any surface and the radon plus its daughter's activity was reduced to levels of less than 10^{-9} μ c/cc. (auth)

18376 ENVIRONMENTAL MONITORING AT GEORGIA NUCLEAR LABORATORIES—AFP 67. J. M. Selby, B. M. Bowen, and J. H. Edgerton (Lockheed Aircraft Corp., Marietta, Ga.). Am. Ind. Hyg. Assoc. J., 22: 114-18(Apr. 1961).

The environmental monitoring program initiated at AFP-67 consists of on-site and off-site sampling. The on-site program provides data on the changes in concentration in the environs and is used for protecting plant personnel from any hazard which might occur. The off-site program provides a continuous record of the fluctuation in background levels and of the effectiveness of the plant radiation controls. The off-site and on-site environmental monitoring programs, consisting of the sampling of soil, vegetation, water, air, animal and marine life, and dose measurements using film, foils, chemical dosimeters, and ionization chamber dosimeters, are discussed. (auth)

18377 A STUDY OF OCCUPATIONAL RADIATION EXPOSURE IN NEW YORK STATE. A. P. Abrahams, P. Carmichael, and M. Kleinfeld (N. Y. State Dept. of Labor, New York). Am. Ind. Hyg. Assoc. J., 22: 124-9(Apr. 1961).

A statistical study of occupational radiation exposure in New York State industry, based on personnel monitoring records, survey data, and results of medical examinations, was made by the Labor Department. Exposures were classified by source, occupation, and industry. The results indicated that over 90% of the exposures were below the NCRP recommended dose limit of 100 mrem/week, and that the contribution of occupational exposure to the general population dose was less than 0.3%. The highest external exposures noted were among workers in radium processing, luminous dial painting, industrial radiography and nuclear fuel element fabrication. Sampling results indicated that air-borne concentrations of radioactive contaminants in all but a few installations were below 10% of the MAAC. (auth)

18378 GUARDING AGAINST MAJOR RADIATION ACCIDENTS IN A LARGE CITY. Daniel E. Lynch (N. Y. City Office of Radiation Control, New York). Am. Ind. Hyg. Assoc. J., 22: 130-2(Apr. 1961).

The New York City plan for handling radiation accidents relies in the main on control at the accident scene by the Police Department, hazard evaluation by the Health Department and Atomic Energy Commission radiation specialists, a communication plan using telephone and Civil Defense two-way radio, and advance information on storage locations or shipments of hazardous quantities of radioactive material. Possibilities of accidents to the water supply and certain other accidents not covered in the plan are discussed. (auth)

18379 CONTRIBUTION TO THE PROBLEM OF WATER PURIFICATION METHODS AND THE VALIDITY TESTS FOR THESE METHODS. [PART] I. E. Plötze. Atomkernenergie, 6: 109-13(Mar. 1961). (In German)

The performance demands placed on water purification plants for radioactive or chemically/biologically contaminated water are reported; such plants in most instances use combined techniques. These demands are contingent upon the "maximum permissible concentration" ($MZK_{w,cm}$) for contaminated water, and upon the biological and chemical determining factors for contaminated and poisoned water; ABC contamination may be caused by industrial waste water or by the influx of overflow drainage as a result of emergency. In addition, the technical quality criteria which are valid for the evaluation of laboratory facilities and mobile or fixed major technical plants are defined. In a further publication some contribution is to be made to the theory of purification processes; the performance characteristics mainly will also be discussed. (auth)

18380 THE PRESENCE OF LONG LIFE ALPHA EMITTERS IN THE AIR. R. Dugnani Lonati (CISE, Milan). Energia nucleare (Milan), 8: 217-20(Mar. 1961). (In English)

During measurements of the air radioactivity, a very weak long life alpha activity was detected. Studies were made to determine the concentration and composition of the alpha emitters. The experimental method is described and the results are graphed. From the energy of the particles emitted and from the fact that the activity increases with time, it was assumed that the activity is chiefly caused by Po^{210} . (J.S.R.)

18381 EVALUATION OF THE SAFETY AND RADIOLOGICAL PROTECTION FACTORS IN THE AUTHORIZATION PROCEDURES FOR NUCLEAR POWER PLANTS. A. Persano (SELNI, Milan), C. Polvani, C. Sennis. *Energia nucleare* (Milan), 8: 287-94 (Apr. 1961). (In Italian)

The problem of the technical evaluation of safety and radiological protection factors is examined, in view of the authorization granted to nuclear plants. The normal operation and the "severe" accidents of plants are considered. The relevant aspects of the evaluation of contamination levels and of doses due to routine effluents are discussed. The techniques employed at present to evaluate the hazards involved in "severe" accidents are critically examined, with particular emphasis on the hypothesis of the "maximum credible accident". (auth)

18382 THE TRANSPORTATION OF RADIOACTIVE MATERIALS. Yves Duvaux (Commissariat à l'Energie Atomique, [Paris]). *Énergie nucléaire*, 2: 295-301 (Sept.-Oct. 1960). (CEA-1869). (In French)

The problems, present and future, posed by the transportation of radioactive materials are analyzed; a review is given of regulations and of risks involved in regulatory systems. It is predicted that caution and carrier specialization are prerequisites to progress and safety in radioactive material transportation. (T.F.H.)

18383 INVESTIGATIONS INTO THE LOW ENERGY GAMMA RAY BACKGROUND AND ITS VARIATIONS. Bijon Roy, Probir K. Sandell, and Ajoy K. Choudhury (Inst. of Post-Graduate Medical Education & Research, Calcutta). *Indian J. Phys.*, 35: 77-85 (Feb. 1961). (In English)

The gamma-ray background of Calcutta as determined by scintillation spectrometry using a NaI (thallium activated) crystal consists of two broad energy bands being contributed by the radioactive substances present in the soil, air, and building materials and identified as those from the radium and thorium family. The background so determined indicates that there are two possible regions of low level counting which is achieved by choosing an optimum channel level and channel width. The variation in intensity of the background is restricted mostly to lower energy region of the background spectrum and is under further investigation. (auth)

18384 NEW METHODS OF DETERMINING THE AIR POLLUTION WITH THE AID OF RADON BY-PRODUCTS. I. I. Gusarov and V. K. Lyapidevskii (Sechenov Moscow Medical Inst. and State Scientific Research Inst. of Roentgen-Radiology). *Med. Radiol.*, 6: No. 1, 52-7 (Jan. 1961). (In Russian)

Two new modes are given for determining the air pollu-

tion with the aid of daughter products of radon. A formula is recommended for assessing the radiation dose absorbed in the lungs, according to data of these methods. The above-mentioned techniques could be utilized in the practice of sanitary dosimetric control over the content of radon daughter products in the air, during studies of the effect of low concentrations of daughter products of radon in the inhaled air. (auth)

18385 SANITARY PROTECTION OF THE ATMOSPHERIC AIR FROM RADIOACTIVE POLLUTION. Yu. V. Novikov (Epismana Moscow Scientific Research Inst.). *Med. Radiol.*, 6: No. 1, 57-61 (Jan. 1961). (In Russian)

The principal aspects are given of the problem pertaining to studies of the radioactivity of the atmospheric air which is of paramount hygienic importance. (auth)

18386 RADIATION CONTROL IN URANIUM MINES AND MILLS. Robert G. Beverly (Union Carbide Nuclear Co.). *Mining Congr. J.*, 47: 77-82 (Apr. 1961).

Problems of radiation control in uranium mines and mills are reviewed. Topics discussed include exposure standards and protection regulations, monitoring and sampling equipment, ventilation, problems of air contamination in crushing and sampling plants, the effectiveness of dust respirators, radiation control problems in wet processing areas, special precautions for concentrate areas, the use of film badges for determining exposure, radium in tailings and effluents, radium removal using barium salts, the release of stack effluents to unrestricted areas, and records required by the AEC radiation control program. (C.H.)

18387 RADIOLOGICAL HEALTH DATA. Volume II, Number 4. Quarterly Report. (Public Health Service, Washington, D. C.). Apr. 1961. 39p. \$0.50 (GPO).

Data are tabulated on the radioactivity in samples of air, foods, milk, surface water, and drinking water collected throughout the United States and Canada during Nov., 1960. Data are included on Cs^{137} levels in humans, the body burden of radioisotopes in people residing in the San Juan Basin, and the Sr^{90} content of samples of human bone and teeth. Data are included on environmental levels of radioactivity in the vicinity of major Atomic Energy Commission installations. (C.H.)

18388 INSTALLATION FOR HYDRAULIC CONDUIT TRANSPORT OF CONTAINERS. (to Commissariat à l'Energie Atomique). British Patent 865,961. Apr. 26, 1961.

A hydraulic conduit system for transporting radioactive materials, explosives, or other dangerous products is described. The system is provided with a lock chamber designed to seal off the contaminated hydraulic fluid from the outer atmosphere, in order that containers may be introduced into the circuit. A hydraulic and mechanical brake is provided at the exit end of the circuit. The circuit may be placed underground for shielding. The use of the system in transportation and storage of irradiated uranium fuel elements, using water as a cooling agent and as the hydraulic fluid, is described.

INDUSTRIAL APPLICATIONS OF ISOTOPES AND RADIATIONS

18389 (CEA-1786) NOUVEAUX DEVELOPPEMENTS DE L'ANALYSE ET DE LA MESURE DES EPAISSEURS PAR EXCITATION DES RAIES DE FLUORESCENCE AU MOYEN DE PARTICULES β . (New Developments in the Analysis and Measurement of Thicknesses by Excitation of the Fluorescent Lines by Means of β Particles). Pierre Martinelli (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay) and Georges Seibel (Institut de Recherches de la Sidéurgie, St.-Germain-en-Laye, France). 1960. 34p.

The process for analyzing and measuring the thickness of deposits by β -x fluorescence, which was previously described, has undergone further development. The use of Pm-147 and Kr-85 sources makes it possible to reduce the background noise which is observed with Sr-90. Results are presented for various measurements of the thickness of metallic coatings, and the continuous measurement of calcium and of iron in ore samples. Tests were carried out with a view to analyzing the x rays by means of a crystal. (auth)

18390 (NP-10056) UTILIZATION OF RADIATION FOR INCREASED SHELF LIFE OF FRESH AND CANNED MEATS. Report No. 2 (Final) for Period May 2, 1959–May 1960. Don Manders (Dubuque Packing Co., Iowa). Contract QMR&E (NATICK) No. 120. 4p.

Radiation levels of 50,000, 150,000, and 250,000 rad followed by cooking in 155°F water failed to produce shelf-stable canned ham. (C.H.)

18391 (NP-10058) A STUDY OF THE RADIATION-INDUCED SOFTENING OF PLANT TISSUES. Progress Report for Period April 1, 1958–May 31, 1960. Report No. 10(Final). Z. I. Kertesz (New York. State Agricultural Experiment Station, Geneva). Contract DA-19-129-QM-1164. 27p.

The radiation-induced softening of lettuce, cherries, and apples was investigated together with changes caused in respiratory behavior during and after irradiation. The two phenomena are apparently unrelated. The new techniques evolved for these investigations are described in detail. (auth)

18392 (NP-10059) UTILIZATION OF RADIATION FOR IMPROVEMENT OF QUALITY OF CANNED HAM AND COMMINUTED MEAT PRODUCTS. Report No. 2 (Final), May 21, 1959–May 20, 1960. V. R. Rupp (Hygrade Food Products Corp., Indianapolis). Contract QMR E (NATICK)-124. 2p.

Irradiated canned hams held for 10 months at 86°F showed no viable aerobic or anaerobic bacteria present. Similar samples held in a cooler at 32°F showed a noticeable off-odor of sufficient magnitude to make them unacceptable as a commercial product. (auth)

18393 (NP-10121) SALINE WATER CONVERSION REPORT FOR 1960. (Department of the Interior. Office of Saline Water, Washington, D. C.). Jan. 1961. 135p.

Research. Over 30 compounds were screened for possible use in demineralization of sea water by hydrate formation; of these compounds, Freon-31 (CH_2ClF), CH_3Br , and Freon-21 (CHCl_2F) appear to be the most promising. Inorganic hydrating agents are briefly considered. The results of studies conducted on the utilization of radioisotopes

as heat sources for various conversion processes are described. Research on osmotic and electrolytic processes is summarized. The use of acoustic vibrations to improve heat transfer rates, promote steam condensation, and reduce scaling in evaporators was studied. A study of scaling by CaSO_4 solutions is presented. Results of a study of supersaturation of CaSO_4 in electrolysers are discussed. Removal of scale-forming elements from water for use as a fertilizer is considered. Research projects on ion membranes for water purification are described. The effect of impressed electrostatic fields on salt water-air interfaces is discussed. Water purification by capillary diffusion and chelates is considered. Corrosion of metals by sea water is discussed. Other possible modes of demineralization are discussed. Processes Development. The projects on process development for water purification are treated in some detail. Among the processes treated are: distillation, solar heat distillation, membrane processes, separation by freezing, hydrate process, and solvent extraction. Some large distillation plants are described. Demonstration Plants. Criteria are listed for selecting demonstration processes and sites. The various plants now being designed and/or constructed are described. (D.L.C.)

18394 (NP-10132) RADIOACTIVE ISOTOPES. Series of Philippine Scientific Bibliographies No. 2. (National Inst. of Science and Tech., Manila). Nov. 1960. 51p.

Five hundred references dealing with the theory and practical utilization of radioactive isotopes are listed. These papers were published in English from January 1957 to December 1960 in 82 periodicals. These references are arranged alphabetically by the name of the first author. Also included are a list of sources of the articles, the year of publication of each article, an index giving the characteristic features of each article, a listing of the geographical aspects of the contents of the papers, a subject index, and an index of joint authors. (M.C.G.)

18395 (NYO-2502) THE TECHNOLOGY AND APPLICATIONS OF LARGE FISSION PRODUCT BETA SOURCES. Quarterly Report, July 1–October 1, 1960. Jacques J. Weinstock, E. Y. Mirocznik, and W. Oliver (Radiation Applications Inc., Long Island City, N. Y.). Oct. 24, 1960. Contract AT(30-1)-2186. 8p.

A powder spreader, developed for use in the fabrication of planar vitreous enamel beta sources, was improved. High recoveries of enamel are achieved by re-use of the melting crucible. All source fabrication procedures and apparatus were modified or adapted for use with remote handling techniques. "Cold" runs were completed in preparation for fabricating Ce^{144} and Pm^{147} sources containing 0.5 to 1.0 mc/sq.cm., and Sr^{90} sources containing about 1 μc /sq.cm. The radiation-induced graft polymerization process for grafting methacrylic acid-styrene on polypropylene is being further developed to be consistent with commercial film and fabric handling techniques. Evaluations are being made of the dyeability of the grafted polypropylene. (auth)

18396 MANUFACTURE OF NEW GRAFT COPOLYMERS. Robert Roy Smith (to B. X. Plastics, Ltd.). British Patent 862,610. Mar. 15, 1961.

A process for the production of graft copolymers of

cellulose triacetate and styrene is described. Cellulose triacetate is subjected to ionizing radiation in the presence of oxygen to form peroxidized active centers (defined in report) on the cellulose triacetate, and the irradiated material is then contacted with monomeric styrene. Instead of styrene, a nuclear-methyl derivative of styrene may be used (a methyl substitution product in which the methyl group or groups are in the nucleus), for example, vinyl toluene or vinyl xylene. Ortho-, meta-, or para-, vinyl toluene, or a mixture of two or all, may be used as isomers. The irradiated material is advantageously contacted with the styrene in the absence of oxygen, in a vacuum or under nitrogen. (N.W.R.)

18397 COATED POLYOLEFIN. (to Dow Chemical Co.). British Patent 862,865. Mar. 15, 1961.

A method is described for coating a surface of non-aromatic hydrocarbon polyolefin derived from mono-olefin monomers containing from 1 to 6 carbon atoms or a surface of copolymer of such non-aromatic hydrocarbon olefins with a chloroethylene polymer resin. The method consists of subjecting the surface to a field of at least 40000 r per hour of metal-penetrating, ionizing, high-energy radiation until the surface has received a dosage of at least 10 Mrad but less than that at which polymer degradation occurs. Subsequently a layer of a chloroethylene polymer resin is applied over the irradiated surface. The dosage is preferably less than 40 Mrad. The irradiated surface has a thickness between 0.5 and 5 mils and the chloroethylene polymer resin film has a thickness between 0.1 and 2.0 mils. The surface to be coated is either polybutylene, polyethylene, or polypropylene. The chloroethylene copolymer resin is comprised either of vinyl chloride and vinyl acetate, vinylidene chloride and vinyl chloride, vinylidene chloride and acrylonitrile, or vinylidene chloride and 1-2 carbon alkyl acrylate. (N.W.R.)

18398 IMPROVEMENTS IN THE TREATMENT OF POLYETHYLENE AND LIKE POLYOLEFINS AND IN PRODUCTS OBTAINED THEREBY. Basil Eccleston

Bartrum (to W. R. Grace & Co.). British Patent 866,820. May 3, 1961.

The properties of polyethylene film or film of a similar polyolefin are improved by radioinduced cross-linking. The polymers must have a molecular weight of at least 12000 to be solid at room temperature. The materials, oriented to some extent by uni-axial or bi-axial stretching during production, are first subjected to high energy ionizing radiation to produce a limited cross-linking. They are then heated and uni- or bi-axially oriented and finally cooled. To promote cross-linking in standard polyethylene it may be mixed with a special polyethylene containing vinyl, vinylene, or vinylidene groups which readily undergo cross-linking. The orientation step following the irradiation may be carried out by stretching or by calendering, but in both cases it is important that the polymer undergoing orientation shall be hot. The irradiation must induce some cross-linking of the polymer and should amount to a dosage of at least 2 Mrep. The improved properties are compared and the equipment used is discussed. (N.W.R.)

18399 IMPROVEMENTS IN VINYL CHLORIDE COPOLYMERS. (to U. S. Rubber Co.). British Patent 866,846. May 3, 1961.

A method is described for improving the physical properties of vinyl chloride copolymers by radioinduced cross-linking. The method consists of shaping to a desired form a resinous copolymer composition of 95 to 50% by weight of vinyl chloride and correspondingly 5 to 50% of one or more monomers copolymerizable from dialkyl maleates (4 to 20 carbons), vinyl esters of fatty acids (3 to 20 carbons), vinyl alkyl ethers (18 to 30 carbons), alkyl acrylates (1 to 20 carbons), or alkyl methacrylates (3 to 20 carbons). The formed composition is then subjected, in the absence of any ethylenically unsaturated plastifying agent, to a dosage of ionizing radiation of 5 to 50 watt-hours per pound. The copolymer is cross-linked and the physical properties are improved. A similar method is discussed for vinyl chloride terpolymers. (N.W.R.)

ISOTOPE SEPARATION

18400 (ORNL-1169(Del.)) ENRICHMENT OF URANIUM 236. B. Harmatz, H. C. McCurdy, F. N. Case, and R. S. Livingston (Oak Ridge National Lab., Tenn.). Dec. 1951. Decl. with deletions Jan. 4, 1960. 47p. Contract W-7405-eng-26.

Neutron-irradiated uranium was electromagnetically separated to provide enrichment of the isotope of mass 236. The final isotopic abundance of U^{236} was determined to be 95% in 1800 milligrams of uranium. Useful by-products of the program were 22 grams of 25% U^{236} and 1100 grams of 99.7% U^{235} . These enriched materials were made available for use on Atomic Energy Commission projects. Possible application of this separation process to recovery of the fuel from the MTR reactor is described. (auth)

18401 (TID-12452) THERMAL FEEDBACK IN COUNTER-CURRENT PROCESSES. [PART] I. Technical Report No. 61A. Herbert A. Pohl (Du Pont de Nemours (E.I.) & Co. Atomic Energy Div., Wilmington, Del. and Princeton Univ., N. J. Plastics Lab.). Apr. 1, 1961. Contract DA-36-039sc-78105. 33p.

A significant variation of temperature may occur in processes involving counter-current mass transfer when only small amounts of heat are generated within the equipment. A quantitative theoretical treatment of the causes is given and the results compared with practice. In the dual temperature isotope exchange process, the presence of unexpected temperature drops of about 5 to 7°C occurred in the first stage cold towers. Since there is an ice-like hydrate of H_2S that forms at about 28°C at the desired operating pressure, any variation in tower temperature is important. The principal cause of the temperature drop was found to be the temperature magnification of small cooling effects, caused by the uniform but non-ideal expansion of H_2S . (auth)

18402 (TID-12453) THERMAL FEEDBACK IN COUNTER-CURRENT PROCESSES. [PART] II. Technical Report No. 61B. Herbert A. Pohl (Du Pont de Nemours (E.I.) & Co. Atomic Energy Div., Wilmington, Del. and Princeton Univ., N. J. Plastics Lab.). Apr. 1, 1961. Contract DA-36-039sc-78105. 22p.

The origin of the temperature peaks which occur in countercurrent processes is discussed. The cause of temperature rises, many times greater than might at first be expected from the small amounts of heat generated within the equipment, is treated quantitatively and compared with observed data. In the dual-temperature isotope exchange process, the presence of unexpected temperature peaks of about 8 to 10°C in the second stage towers adversely affected operation. The cause of the temperature peaks is thermal feedback in the counter-current process, the source of internal heat being the small heat of reaction for the isotope exchange. (auth)

18403 (AEC-tr-4567) RESULTS OF LOW-TEMPERATURE RESEARCH XXXV. SIMULTANEOUS ENRICHMENT OF N^{15} , O^{17} , AND O^{18} BY RECTIFICATION OF NITRIC OXIDE. K. Clusius, K. Schleich, and M. Vecchi. Translated from *Helv. Chim. Acta*, 44: 343-61(1961). 55p. (Includes original, 19p.).

A vacuum column for the rectification of nitric oxide is described which is suitable for a simultaneous enrichment of isotopes N^{15} , O^{17} , and O^{18} . The amount of nitric oxide necessary for operation was reduced by a factor of 100 by recharging the depleted nitric acid in an exchanger column,

in which a concentrated solution of $NaNO_3$ in $HN O_3$ was circulated. The experiment including a starting phase, a production phase lasting 600 hrs, and an end phase operating with total reflux in which a concentration of 25.32% N^{15} , 1.33% O^{17} , and 47.50% O^{18} was reached in the still, while 0.61% N^{15} , 0.12% O^{17} , and 0.23% O^{18} were present at the head is described. This confirmed the practical applicability of NO-rectification for a simultaneous enrichment of the three heavy isotopes of nitrogen and oxygen. The theoretical concentration distribution of the individual molecule types along the column was calculated on the basis of earlier determinations of the separation parameters with the assumption of validity of Raoult's law. The components with separating parameters smaller than that between $N^{14}O^{16}$ and $N^{16}O^{16}$ passed through concentration maxima along the column. (M.C.G.)

18404 (CEA-tr-R-1226) CONCENTRATION DES ISOTOPES STABLES PAR LA METHODE DE RECTIFICATION ET D'ECHANGE CHIMIQUE ISOTOPIQUE. (Concentration of Stable Isotopes by the Method of Distillation and Isotopic Chemical Exchange). N. M. Zhavoronkov, S. I. Babkov, and O. V. Ouharov. Translated into French from Collection Czechoslov. Chem. Commun., 23: 1727-34(1958). 18p.

The construction of fractionation apparatus was studied with the aim of enriching N^{15} and O^{18} on an industrial scale. The principles of the installation are described, and the operational characteristics of two types of fractionators—packed column with fine metallic spirals and a horizontal apparatus with rotating discs—are given. These two apparatus meet high requirements with respect to capacity, hydraulic resistance, and construction dimensions. The enrichment kinetics for the heavy component was studied for these apparatus. The experimental data do not support the hypothesis that the variation of concentration at different stages begins almost from the moment when the stationary state is obtained. The relation for the distribution of concentrations in the column is formulated for the case when the systems obey the Raoult and Henry laws. The procedures for the preparation of N^{15} and O^{18} concentrates in the installations of a large scale are described. (tr-auth)

18405 VARIOUS APPROXIMATIONS FOR THE ISOTOPIC THERMAL DIFFUSION FACTOR. [PART] I. APPLICATION TO HELIUM ISOTOPES. S. C. Saxena and P. A. Pardeshi (Atomic Energy Establishment, Trombay, India). *Indian J. Phys.*, 35: 55-61(Feb. 1961). (In English)

Various formulas for the isotopic thermal diffusion factor are reviewed and a new formula is derived. Numerical calculations are performed for the particular case of He^3 - He^4 in a region where quantum effects are negligible. These calculations establish the relative adequacy of a comparatively simpler formula advanced and will be useful to interpret the recent experimental results of Saxena, Kelley, and Watson on the thermal diffusion factor as a function of temperature. (auth)

18406 THE ENRICHMENT OF LITHIUM ISOTOPES BY ION EXCHANGE CHROMATOGRAPHY. III. THE INFLUENCE OF THE NATURE OF THE SOLUTION PHASE ON THE SEPARATION FACTOR. D. A. Lee (Oak Ridge National Lab., Tenn.). *J. Am. Chem. Soc.*, 83: 1801-3 (Apr. 20, 1961).

Single stage separation factors (α) for Li^6 and Li^7 were determined in ion exchange systems containing various other cations and anions in the solution and resin phases.

Dehydration of the lithium species in the resin phase may be the major contribution to the change in the isotopic separation factor. The hydrating tendency of the co-ions in the resin phase is directly related to the magnitude of the separation factor. The effect of coordination of the lithium species with EDTA also is discussed. (auth)

18407 DESIGN METHODS FOR DUAL-TEMPERATURE CHEMICAL EXCHANGE PROCESSES FOR PRODUCTION OF DEUTERIUM. C. J. Lyon (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.60-6 of "Proceedings of the Joint Symposium on Instrumentation & Computation in Process Development and Plant Design." London, The Institution of Chemical Engineers, 1960.

The design of a dual-temperature chemical exchange process for the production of deuterium is discussed. Liquid feed of low deuterium concentration is enriched by flowing in a packed or bubble-cap tower at a low temperature counter-current to a hydrogen-containing gas. A portion of the enriched liquid leaving this tower is withdrawn as product; the remainder is passed through a simi-

lar tower at a higher temperature. Here the deuterium is stripped from the liquid by gas recycled from the top of the cold tower. The physical data and mass-transfer equations being known, the equations are programmed for an electronic digital computer so that the effects of different process conditions can be compared and an optimal set chosen. (auth)

18408 PROCESS FOR THE PRODUCTION OF HEAVY WATER. (to Ruhrchemie A. G. and Steinbohlen-Elektrizität A. G.). British Patent 865,411. Apr. 19, 1961.

An improved hot-cold process is given for producing heavy water by deuterium exchange between hydrogen and water. In this process, the isotopic exchange is carried out in the presence of nickel, iron, or cobalt in the form of Raney catalyst, which may be prepared according to British Patent 806,644. The water subjected to isotopic exchange preferably is 0.05 to 2 N in potassium hydroxide. The cold and hot towers in the hot-cold system preferably are operated at temperatures of 40 to 80°C and 160 to 200°C, respectively, and at a pressure of 10 to 30 kg/cm². (D.L.C.)

MATHEMATICS AND COMPUTERS

18409 (AFCRL-TN-60-1109) ON THE EVALUATION OF FEYNMAN PATH INTEGRALS. Scientific Report No. 1. Fazıl Erdogan (Parke Mathematical Labs., Inc., Carlisle, Mass.). Sept. 1960. Contract AF19(604)-7316. 50p. (AD-246923)

A brief description of the nature of the probability measure in quantum mechanics is presented and followed by introduction of Feynman's postulates for the quantum mechanics, and a concise derivation of his formulation of the Lagrangian quantum mechanics in terms of integrals in function spaces. The practical methods of evaluation of these integrals are then presented. A parametrization by means of orthonormal functions is described and some examples are given. The method is shown to be applicable to more than one degree of freedom systems. A parametrization by means of a finite number family of curves (or representation by means of a finite series) leading to an approximate solution is also described and the nature of approximation is indicated by using in an example. The normalizing factor of the path integral is discussed and a general method is given which determines this factor in the case of separable actions. Determination of the energy eigenvalues from the Green's function in the case of discrete systems are discussed and an example given by Burton and de Borde is included. A quasi-classical approximation developed by Morette is also examined. (auth)

18410 (AN-237) HATCHET—A COUPLED NEUTRONICS-HYDRODYNAMICS CODE TO CALCULATE BURST CHARACTERISTICS OF A PULSED REACTOR FOR IBM 704. J. P. Lehman (Aerojet-General Nucleonics, San Ramon, Calif.). Sept. 15, 1960. 89p.

The HATCHET code which computes specific energy, temperature, pressure, density, and velocity variations as a function of time and space for a super-prompt critical concentric shell pulsed reactor is presented. It computes reactivity as a function of inverse reactor period, power, the total and kinetic energies, and the position of the shells which comprise the system. Delayed neutron effects are ignored, and no allowance is made for heat transfer. The code is limited to a maximum of three neutron energy groups and six materials. A technical discussion of the code together with basic assumptions and equations is included. A flow diagram, sample problem, and operating instructions are included. A tape dump and recall routine and a FORTRAN listing of the program are appended. (B.O.G.)

18411 (JINR-E-675) INTEGRAL EQUATIONS FOR π - π SCATTERING AND CONVERGENCE PROBLEMS OF THE AMPLITUDE EXPANSION. S. Ciulli and J. Fischer (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1961. 11p.

The convergence problems connected with the cosine expansions for deriving integral equations from the Mandelstam representation are studied for π - π scattering. A set of equations for low energies is given in which a good convergence of the real part of the amplitude expansion is achieved with the help of a conformal transformation of the cosine plane. Since each power of the expansion function contains an infinity of partial waves, this approach is convenient in cases in which higher waves are expected to play an important role. (auth)

18412 (PAN-188/XII) ON NUMBERS REPRESENTATION FOR COMPUTING. (O Przedstawianiu Liczb dla

Celów Obliczeniowych). A. B. Empacher (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Nov. 1960. 6p.

A discussion is presented on algorithms for arithmetical operations on numbers x represented in the form $x = a^\delta$, where exponent $\delta = +1$ for $|x| \leq 1$, and $\delta = -1$ for $|x| \geq 1$, so that the inequality $|a| \leq 1$ always occurs. In application to automatic computers, this inverse-point method is intermediate between fixed- and floating-point arithmetic. Generalization of the number sign is also considered. (auth)

18413 (TID-11825) RADIOISOTOPE DIFFUSION IN A HOLLOW CYLINDER—COMPUTE PROGRAM 0607. W. R. Strong, J. R. Beeler, and B. Kaplan (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Dec. 1, 1960. 22p. (XDC-61-2-43)

GE-ANPD Program 0607 for the IBM 704 computer is described. This program computes the total radioisotope diffusion current per unit length at each wall of a hollow cylinder. The source function for the isotope concerned must be radially uniform but an arbitrary time dependence can be assigned. It is also possible to assign an arbitrary initial concentration distribution at a given time. There is an option for using an extrapolation technique to reduce truncation error. The program will normally printout the diffusion current at each cylinder wall as a function of time; however, there is an option for obtaining a printout of the concentration, as well, as a function of the radial coordinate and time. (auth)

18414 (TID-12644) FLOW-GATING. Report (Final) No. 106. Henry Guckel, Toshiro Kunihiro, and Ronald K. Crow (Illinois. Univ., Urbana. Digital Computer Lab.). Mar. 24, 1961. Contracts Nonr-1834(15) and [AT(11-1)-415]. 97p.

Transistor selection and evaluation, basic design problems, and evaluation of the flow-gating memory are discussed. The proposed system consists of 14 flow-gating flipflops, the read-in driver, the read-out driver, and termination equipment. Free-running delay calibration tests, marginal and read-out tests, cycle time determinations, and physical layout are described. (M.C.G.)

18415 (TID-12718) PROGRAM 0434 FOR COMPUTING THE LIGHT PULSE SPECTRUM OF A TRANSPARENT CRYSTAL SUBJECTED TO A MONOENERGETIC NEUTRON BEAM. Monte Carlo Research Series. J. R. Beeler (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Jan. 1961. Contracts AT(11-1)-171 and AF33(600)-38062. 20p. (XDC-61-3-89)

Program 0434 is a FORTRAN II program, coded for either the IBM 704 or 7090, which computes the light pulse spectrum of a transparent crystal subjected to a monoenergetic neutron beam. The crystal may be composed of five or less different chemical elements. An arbitrary distribution of the center of mass scattering angle, as a function of neutron energy, can be prescribed for four elements. Isotropic center of mass scattering is assumed for hydrogen and hence the program is limited to neutron energies less than 14 Mev if hydrogen is used. Because the pulse spectrum reported by a scintillation counter system depends upon both the neutron beam intensity and the response time of the electronic circuitry involved, two versions of the program were written. The Single Collision version assumes the counter system is able to distinguish

between individual neutron collisions. The Total History version assumes that only individual neutron histories can be distinguished. Both versions allow a scattering order analysis of contributions to the pulse spectrum to be made. Up to 1000 arbitrary energy intervals can be used to describe the light pulse spectrum. (auth)

18416 (TID-12740) REVISED ITERATION SEQUENCE IN PROGRAM F-N. P. G. Fischer (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Feb. 7, 1961. Contracts AF 33(600)-38062 and AT(11-1)-171. 9p. (XDC-61-2-131)

The iteration sequence used in the multigroup Program F-N (ANP No. 308) in which one energy lattice sweep, a so-called inner iteration, is performed for each space power distribution sweep, an outer iteration, exhibited a painfully slow convergence rate in the presence of significant "up-scattering" even for the typical ANP reactor where the dominance ratio between fundamental and first harmonic space modes is about five. A revised iteration sequence in which the energy lattice sweep is iterated to a desired convergence before repeating the power iteration is outlined. The revised procedure should significantly reduce the machine time required for this type of problem. (auth)

18417 (TID-12741) MONTE CARLO VOLUME APPROXIMATION. J. J. Loechler (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Mar. 20, 1961. Contracts AF 33(600)-38062 and AT(11-1)-171. 24p. (XDC-61-4-19)

Monte Carlo Volume Approximation (GE-ANPD Program 708) is a digital computer program which applies a Monte Carlo method for approximating the volumes of any number of various shaped regions, which may appear in various configurations. All volumes are approximated at the same time. The program is coded in FAP for an IBM-7090 computer, with the amount of input determining the amount of fast memory required. The program proper requires only

the first 2600₁₀ storage locations. Magnetic tape units are used solely for input and output using one data channel.

(auth)

18418 (AEC-tr-4542) METHODS OF COMPUTATION OF NONLINEAR TOLERANCE CHAINS. Vladimir Klega. Translated from Strojnoelektrotech. casopis, 9: 523-30 (1958). 12p.

Considerations are given for the calculation of the tolerance of the closing link of a nonlinear dimensional chain by the maximum-minimum method and the statistical method. It is shown that the relation for the maximum-minimum method in the general case is the same as the relation for a linear chain. A calculation is made of the mean error in establishing a sine rule. (B.O.G.)

18419 AN ELECTRONIC COMPUTER (BESK) PROGRAM FOR ONE-ELECTRON TWO-CENTRE INTEGRALS OF HARTREE-FOCK SELF-CONSISTENT FIELD FUNCTIONS IN ANALYTICAL FORM. E. Forslind, S. Forsén, and A. Rupperecht (Royal Inst. of Tech., Stockholm). Arkiv Fysik, 18: 563-8(1961). (In English)

An electronic computer program is described which permits the computation of the following one-electron two center integrals: overlap, moment, resonance, kinetic energy, and nuclear attraction. The quantum chemical integrals are calculated by means of spheroidal coordinates in atomic units. The computations of overlap and moment integrals involving s and p functions are shown. The program can also be applied to Slater functions. (N.W.R.)

18420 BOUNDARY AND EIGENVALUE PROBLEMS IN MATHEMATICAL PHYSICS. Hans Sagan. New York, John Wiley & Sons, Inc., 1961. 394p. \$9.50.

The theories of orthogonal systems and eigenvalues are investigated in a study of self-adjoint boundary value problems that arise in physics. The mathematical treatment of the problems utilizes Hamilton's principle, Bernoulli's separation method, spherical harmonics, variational methods, Fourier series, and Legendre and Bessel functions. (T.F.H.)

METALS, CERAMICS, AND OTHER MATERIALS

General and Miscellaneous

18421 (DMIC-Memo-102) REVIEW OF RECENT DEVELOPMENTS ON OXIDATION-RESISTANT COATINGS FOR REFRACTORY METALS. W. D. Klopp (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Apr. 26, 1961. 5p. (PB-171621)

A review of recent developments in oxidation-resistant protective coatings for Nb, Ta, and Mo is presented. (J.R.D.)

18422 (KY-364) PROBLEMS, TESTS, AND INVESTIGATIONS OF MATERIALS OF CONSTRUCTION FOR THE PADUCAH GASEOUS DIFFUSION PLANT COOLING TOWERS. J. R. DeMonbrun and J. R. Largey (Union Carbide Nuclear Co. Paducah Plant, Ky.). Mar. 24, 1961. Contract W-7405-eng-26. 94p.

The problems encountered in operating four high temperature cooling tower installations are discussed. Tests and investigations of construction materials and protective coatings to determine their application in cooling towers are summarized. (auth)

18423 (NAS-NRC-Pub-871(p.154-7)) PRODUCTION OF HIGH RESISTIVITY SILICON. T. S. Benedict (Merck and Co., Inc. Electronic Chemicals Div., Rahway, N. J.).

The production of high-resistivity silicon is discussed briefly. The final purification is done in the zone refiner. A point in the zone refining process is reached where an additional zone pass will produce a p-n junction along the crystal length, and in the neighborhood a region ~ 1 cm long is found where the resistivity is greater than 5000 ohm-cm. Resistivity gradients are discussed. Gold-doped silicon is considered. Vapor deposition of silicon on silicon substrates is discussed. (D.L.C.)

18424 (NAS-NRC-Pub-871(p.158-63)) DENDRITIC GROWTH OF Ge and Si. C. H. Church (Westinghouse Electric Corp. Research Labs., Pittsburgh).

The way dendrites grow out of the melt and a procedure for producing dendrites are described. Microstructures of dendrites with and without dislocations and produced by pulseplating are discussed. Nearly intrinsic Ge dendrites have been prepared, and two-foot long Si dendrites have been grown. The segregation characteristics of the dendritic mode of growth are discussed. (D.L.C.)

18425 NMI-2071(Del.) FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. Progress Report for July 1 through October 31, 1958. (Nuclear Metals, Inc., Concord, Mass.). Nov. 28, 1958. Decl. with deletions Apr. 25, 1960. 55p.

Investigations on beryllium metallurgy included activation analyses for oxygen, cladding for uranium fuel elements, random orientation in wrought beryllium and its alloys. Uranium metallurgical studies consisted of high-strength cladding for fuels, interdiffusion heat treatment, hollow fuel pins, TREAT diffusion, TREAT-thermite, and BNL Al-U foils. Aqueous corrosion studies were made for thorium alloys. Developments in zirconium metallurgy were devoted to work on high-temperature corrosion-resistant alloys, cladding and tubing textures, and ribbed tubing. Discussions are presented of investigations on: extrusion bonding, shift, and whiskers in coextruded rods and tubes; yttrium fabrication; multi-temperature extrusions; and solution techniques in x-ray fluorescent spectrometry. (B.O.G.)

18426 (NP-10052) MONTHLY ACCESSION LIST NO. 46 [ON RADIATION EFFECTS DATA]. (Battelle Memorial Inst. Radiation Effects Information Center, Columbus, Ohio). Apr. 15, 1961. Contract AF33(616)-7375. 21p.

Annotated citations are given for 65 references to reports and published information on electrical and electronic systems, polymeric materials, organic materials, ceramic materials, alloys and metals, dosimetry, facilities, and space environment. (B.O.G.)

18427 (SB-452) HIGH TEMPERATURE METALLURGY AND HEAT RESISTANT ALLOYS. OTS Selective Bibliography. (Office of Technical Services, Washington, D. C.). Feb. 1961. 36p.

A bibliography is presented consisting of 674 references to reports, which were added to the OTS collection from 1950 to February 1961, on high-temperature metallurgy and heat-resistant alloys. (B.O.G.)

18428 (TID-10059(Del.)) PROCEEDINGS OF THE SPRING METALLURGY CONFERENCE, HELD AT AMES, IOWA, MARCH 24-26, 1952. VOLUME II. (Ames Lab., Ames, Iowa). June 1952. Decl. with deletions Feb. 16, 1960. 439p.

Presented are 36 papers of the proceedings which are concerned with the production of beryllium and zirconium, the physical properties and alloys of uranium, fuel element fabrication, metallurgy of thorium and zirconium, structures of metals, and general physical metallurgy. (B.O.G.)

18429 REFRACTORIES FOR URANIUM REDUCTION. C. Arne Arenberg (Illinois Inst. of Tech., Chicago), Carl W. Boquist, and O. R. Magoteaux. Am. Ceram. Soc. Bull., 40: 304-7 (May 1961).

Commercially available refractory materials were investigated not only for inertness toward the reactants and products of the reduction of uranium tetrafluoride by magnesium but also for contamination of the metal by undesirable impurities. High purity magnesia-alumina spinel was found to be a satisfactory material for fabrication into containers for the reduction process. (auth)

18430 COBALT MONOGRAPH. Brussels, Centre d'Information du Cobalt, 1960. 527p. Available from: Brussels, M. Weissenbruch S. A.

The mechanical, physical, and chemical properties of cobalt are given and discussed. The use of cobalt in alloys, cemented carbides, and other applications are reviewed generally. Current information is presented as to the occurrence, mining, milling, and extractive metallurgy of cobalt. Attention is given to the medical and agricultural aspects of cobalt use and to industrial applications of cobalt radionuclides. (T.F.H.)

18431 IMPROVEMENTS IN METALLURGICAL FURNACES FOR VERY HIGH TEMPERATURES. (to Commissariat à l'Energie Atomique). British Patent 866,648. Apr. 26, 1961.

A furnace is described that consists of a crucible covered by a bell-shaped dome. The crucible has sloping sides that funnel into a second, ingot-shaped crucible. The furnace is designed for carrying out high-temperature metallurgical processes for mixtures of substances. The furnace is specifically designed for the production of very pure U by the reaction of UF_4 with a reducing metal such as Ca. In UF_4 reduction, the furnace is lined with CaF_2 , which does not react with either reactants or products. Means are

provided for cooling the ingot of U formed in the second crucible, and for making the furnace fluidtight. (T.F.H.)

18432 PROCESS FOR THE PURIFICATION OF TITANIUM TETRACHLORIDE OR ZIRCONIUM TETRACHLORIDE. James Thomson Richmond and Howard Arthur Stanley Bristow (to Laporte Titanium, Ltd.). British Patent 866,711. May 3, 1961.

A process is described for separation of TiCl_4 or ZrCl_4 from V, Cr, Fe, and other metallic impurities. The impure gaseous tetrachloride is passed through a fluidized bed containing H_2S or a metal sulfide. At a temperature below the reaction temperature of TiCl_4 or ZrCl_4 with the sulfide (140 to 300°C for TiCl_4 , 300 to 350°C for ZrCl_4) the V, Cr, Fe, and other impurities react to form solid products that remain in the bed. Sand is used as a bed when H_2S is employed. (T.F.H.)

Corrosion

18433 (ANL-6206) CORROSION OF SOME REACTOR MATERIALS IN DILUTE PHOSPHORIC ACID. J. E. Draley, S. Greenberg, and W. E. Ruther (Argonne National Lab., Ill.). Apr. 1961. Contract W-31-109-eng-38. 19p.

Corrosion tests in dilute phosphoric acid (pH 3.5) at elevated temperature are described for X8001 aluminum, 18-8 stainless steels, aluminized carbon steel, and Zircaloy. In a 307-day dynamic test at 18 ft/sec and 315°C, X8001 aluminum corroded at a rate of $\frac{1}{2}$ mdd for the first 240 days. In subsequent exposures, the corrosion rate increased, but the total average penetration at 307 days was only 0.0005 inch. At 200 days, the total corrosion in this test was one-fiftieth that in distilled water. Static tests at 225°C gave corrosion rates too low to measure (<0.2 mdd). Of several different 18-8 stainless steels tested in this solution at 315°C, only sensitized type 316 suffered intergranular attack. General attack rates of the other samples, of the order of $\frac{1}{4}$ mdd, were obtained for the period from 94 to 186 days. Although this is much larger than the rate in distilled water, it represents a penetration rate of only about 5×10^{-6} inch/year. Aluminized carbon steel did not suffer rapid corrosion in this solution at 315°C, even when large areas of the carbon steel were exposed. There was a tendency for corrosion to separate the steel and aluminum with some specimens, depending on the heat treatment. Zircaloy-2 and Zircaloy-3 corrosion were of the same order in this solution at 315°C as in water. (auth)

18434 (ANL-6230) FILM GROWTH ON ALUMINUM IN HIGH-TEMPERATURE WATER. Raymond K. Hart and Westly E. Ruther (Argonne National Lab., Ill.). Apr. 1961. Contract W-31-109-eng-38. 25p.

Film growths on aluminum and two aluminum-1 wt.% nickel alloys in water at 250 and 350°C were studied. It was found that oxide growth does not advance on a uniform front but, to the contrary, the advancing surface contains many outcrops in the form of thin platelets, chunky outcrops, and whiskers. With both the pure metal and the alloys considerable intergranular attack was observed. The general corrosion product was usually more uniform in crystal size when formed on the pure metal, but variations in crystal size were observed on both aluminum and alloys with varying features of the metal surface. The roughness of the general oxide surface (including outcrops) was found to increase rapidly to about 0.2 micron and then remain relatively constant with increasing film thickness. The composition of films formed under all investigated conditions, except one, was found to be boehmite ($\alpha\text{-Al}_2\text{O}_3 \cdot \text{H}_2\text{O}$). This exception was films carried by the alloy specimens after testing for

32 days at 350°C. In this case the main corrosion film was still boehmite, but in addition the outer surface supported long needles of diasporite ($\beta\text{-Al}_2\text{O}_3 \cdot \text{H}_2\text{O}$). (auth)

18435 (CEA-1702) COMPATIBILITE DE DIVERS ALLIAGES DE MAGNESIUM AVEC LE GAZ CARBONIQUE SOUS PRESSION ENTRE 400 ET 600°C. (Behavior of Various Magnesium Alloys in Carbon Dioxide Under Pressure, Between 400 and 600°C). Raymond Darras, Pierre Bague, and Claudine Chevilliard (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1960. 38p.

The following materials were studied: nuclear magnesium, two Mg-Zr alloys, a "Magneox" type alloy, a Mg-Mn alloy, and a "sintered magnesium oxide." The samples, taken from drawn metals, are suitably polished and given two reproducible surface conditions for purposes of comparison. The tests were carried out in purified carbon dioxide, at 25 to 60 atmospheres and 400 to 600°C, using special, externally heated stainless steel autoclaves. The duration of the tests is generally more than 1000 hours. The equations of the weight increase curves obtained are of the type: $(\Delta p)^n = k \cdot t$ (Δp in mg/cm^2 and t in hours), the index n being around 2, at least up to 500°C. Referring to results obtained previously in the case of certain of the materials exposed to carbon dioxide at atmospheric pressure and at 15 atmospheres, it appears that for a given material: at a given pressure, oxidation increases with temperature, at a given temperature oxidation increases with pressure, and under the same temperature and pressure conditions, the results vary little according to the two surface states studied; Mg-Zr alloys show better oxidation resistance than non-alloyed magnesium; and the magnox alloy shows up much less favorably in carbon dioxide than in air, compared with the other alloys. Generally speaking, the oxidation curves tending toward a threshold after a certain exposure time, all the alloys considered appear to show a satisfactory compatibility with carbon dioxide up to 500°C, under the working conditions defined; above 500°C, differences appear between various alloys, but sublimation phenomena interfere with the oxidation, with the result that a classification of the various materials can only be based on their resultant. (auth)

18436 (CF-61-4-77) EXAMINATIONS OF PUMP IMPELLERS FROM SODIUM AND FUSED SALT PUMP ENDURANCE TESTS. J. H. DeVan (Oak Ridge National Lab., Tenn.). Apr. 10, 1961. 13p.

Examinations of three Inconel pump impellers were made to establish the extent of cavitation damage and degree of carburization sustained during pump endurance tests. The pumps, two of which circulated fluoride salt and one sodium, operated for the bulk of the test programs in the temperature range 1000 to 1250°F. Cavitation damage was manifested in each of the impellers by the formation of deep pits (in excess of $\frac{1}{4}$ -in.), the location of damaged areas varying with impeller geometry. Pit formation appeared to have occurred by uniform rather than preferential removal of metal components. Each of the impellers exhibited heavily carburized zones along exposed surfaces. The cause of carburization may be associated with the type of gas purge utilized for these pumps. (auth)

18437 (DP-574) REPROCESSING OF POWER REACTOR FUELS THIRTEENTH QUARTERLY PROGRESS REPORT, OCTOBER 1, 1960 TO JANUARY 1, 1961. Francis G. D. Rust, comp. (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Apr. 1961. Contract AT(07-2)-1. 14p.

The corrosion of 304L stainless steel by boiling solutions

of electrolytically dissolved Zircaloy-2 was found to be less than 3 mils per year (mpy). At 85°C the corrosion of 304L stainless steel by electrolytically dissolved stainless steel in nitric acid was about 10 mpy. Operation at 90°C did not decrease the dissolution rate of UO_2 appreciably below that at the boiling point. During the electrolytic disintegration of zirconium-uranium alloy, sludge was formed that contained uranium from both phases of the alloy. X-ray diffraction studies of the sludge indicated that the uranium was retained as $(\text{Zr-U})\text{O}_2$. (auth)

18438 (GEAP-3548) CORROSION BEHAVIOR OF SOME METAL BORIDES. E. W. Hoyt, J. Chorne', and W. V. Cummings (General Electric Co. Vallecitos Atomic Lab., Pleasanton, Calif.). Oct. 18, 1960. Contract AT(04-3)-189. 20p.

Results are presented of tests in which metal borides were subjected as powders and dense solids to boiling water and 400°C steam. Results indicate that the use of boron-bearing materials as control elements in water cooled or moderated reactors is limited to some extent by their corrosion behavior. (J.R.D.)

18439 (LS-75) BIBLIOGRAPHY ON CORROSION AND OXIDATION OF URANIUM. S. Scapa and M. Gazith, comp. (Israel. Atomic Energy Commission, Tel-Aviv). Dec. 1960. 26p.

References obtained in a search of the literature from 1948 to 1960 are presented. (100 references) (J.R.D.)

18440 (MND-E-2013) ERDL-NPFO QUARTERLY PROGRESS REPORT NO. 15, JANUARY-MARCH, 1961. C. Eicheldinger (Martin Co. Nuclear Div., Baltimore). Apr. 1961. Contract DA-44-099-ENG-3581. 29p.

The first series of three 2000-hour autoclave tests on Monel and nickel coupons was completed. In one autoclave, charged with water containing 1000-ppm chloride and 15-ppm oxygen, the Monel coupon in the vapor phase experienced mild pitting. Average corrosion rates were: for Monel, 0.51 mdd; and for nickel, 0.37 mdd (milligrams per square decimeter per day). A 2000-hour autoclave test on nickel, under conditions which caused pitting of Monel, was initiated. A total of 672 hours of testing was accumulated. The corrosion loop operated virtually continuously during the quarter. Average operating time efficiency (OTE) was approximately 84%. The only major shutdown was caused by failure of terminals on one of the primary 50-kw line heaters. Testing of the bimetal model vessels (MOD SX-4) and the Inconel model vessels (MOD SX-7) continued. Cumulative test time to date is approximately 2350 hours. Testing of the bimetal miniature vessels (MIN 15 and 16) and the Inconel miniature vessels (MIN 10 and 11) continued. Average cumulative test time is approximately 2420 hours. Analysis of heat transfer data was started. Preliminary results for the model vessels indicate that large effects on heat transfer due to scaling have not occurred. (auth)

18441 (TID-12223) CORROSION PROBLEMS. Quarterly Working Report No. 1, March 1 to May 31, 1960. (Brussels. Centre Belge d'Etude de la Corrosion; Brussels. Centre d'Etude de l'Energie Nucleaire; and Brussels. Societe d'Etudes, de Recherches et d'Applications pour l'Industrie). June 1960. AEC 94/Euratom 124. 84p. (Includes original, in French, 46p.).

Research studies were begun for Types 304, 316, and 410 stainless steel, in which special attention was paid to specimen development, processing techniques, and operational aspects of potentiostatic investigations leading to establishing reproducible tension-current curves. Current results show that the curves differ widely according to the

nature of the steel, in the presence of H_2SO_4 , and chloride contents, in NaHCO_3 solutions containing NaCl. The radiation effects were studied for pure aluminum in NH_4NO_3 and $(\text{NH}_4)_2\text{HPO}_4$ solutions. Discussions are given of chemical analyses, physical examinations, and methods of processing the aluminum and stainless steel specimens. (B.O.G.)

18442 EFFECT OF CHLORIDE IONS ON THE ELECTROCHEMICAL AND CORROSION BEHAVIOR OF ZIRCONIUM. Ya. M. Kolotyarkin and V. A. Gil'man (Karpov Inst. of Physics and Chemistry, USSR). Doklady Akad. Nauk S.S.S.R., 137: 642-5 (Mar. 21, 1961). (In Russian)

The static electrode potentials of 99.8% Zr (0.065% Hf) were measured in 1.0 N, 0.1 N, and 0.01 N HCl, and also in 1 N H_2SO_4 , KBr, and KI for comparison. Zr in 1 N H_2SO_4 is passivated with a static potential of -0.16 to -0.18 volts (with respect to the potential of a normal hydrogen electrode) and with a dissolution rate of 5×10^{-7} amps/cm². In HCl solution the static potential of a Zr electrode rises to a certain critical value (ϕ_{cr}) where rapid dissolution of the Zr takes place with no further increase in the static potential. Increasing the chloride ion concentration by a factor of 10 shifts the critical potential 65 m volts to the negative side. The addition of trivalent iron to a chloride solution leads to a shift of the critical potential to the positive side. Pit corrosion is observed on applying anodic polarization or on adding Fe^{3+} to a chloride solution. The corrosion is reversible and can be stopped by removing the conditions causing activation of the metallic surface. This reversibility can be explained in terms of two competing processes. The surface is passivated by the absorption of oxygen in the water, and it is activated by the displacement of oxygen by halide ions. (TTT)

18443 IMPROVEMENTS IN AND RELATING TO PROTECTION OF GRAPHITE BODIES AGAINST HIGH TEMPERATURE OXIDATION. John Graham Swinton Biram (to English Electric Co.). British Patent 866,818. May 3, 1961.

A process for applying a protective coating to graphite is described. Si powder is applied evenly to the graphite surface by painting and baking, or by flame spraying. The firmly-bonded Si layer is then exposed to local high temperatures, without heating the entire graphite body. At temperatures above the melting point of Si, the Si flows into the graphite forming SiC. The coating is oxidation-resistant. (T.F.H.)

Fabrication

18444 (AAEC/TM-51) THE PREPARATION OF A SET OF BeO-BASED FUEL ELEMENT SPECIMENS FOR THE H.T.G.C. IRRADIATION PROGRAMME. K. D. Reeve and E. J. Ramm (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Oct. 1960. 28p.

Ceramic fuel element specimens consisting of a uranium oxide-thorium oxide solid solution dispersed in beryllium oxide were fabricated by hot pressing in graphite dies. Details of fabrication techniques are given. Tests for overall composition, homogeneity and size and shape of fuel grains made during and at the completion of the work indicate that the specimens are in general agreement with initial specifications. (auth)

18445 (BM-RI-5759) PRODUCTION OF ZIRCONIUM BY THE SEMICONTINUOUS REACTOR PROCESS. James E. Mauser (Bureau of Mines, Albany, Ore.). Apr. 1960. 17p.

An investigation was conducted of a continuous process for producing pure zirconium. The metal was produced by

reducing zirconium tetrachloride with sodium and magnesium beneath molten byproduct salt. Hydraulic rams at each end of a vertical reaction tube compacted the sponge and ejected it as a billet. The billets were purified by heat under vacuum to remove entrapped salt. It was concluded that the most satisfactory billets were produced at a temperature of 825°C. The magnesium-produced billets contained as much as 83% by weight of zirconium metal. The sodium and magnesium bimetal-produced billets contained as little as 0.62% salt upon purification. A consumable electrode was melted directly from a compacted and purified billet. Improved production techniques led to a steady decrease in billet impurities, but intermittent operation resulted in high oxygen levels and consequent metal hardness (Rockwell A 64). Continuous operation of the reactor was difficult because of weld failure, corrosion, and recurrent plugging of the lines by salt and reaction products. The lack of more suitable construction materials resulted in high maintenance costs. (auth)

18446 (BMI-RI-5774) A BORON-BASE REFRACTORY. Perry G. Cotter (Bureau of Mines, Norris Research Lab., Norris, Tenn.). Oct. 1960. 7p.

The investigation was conducted to synthesize and investigate the properties of a high-temperature refractory material based on a combination of boron, silica, and magnesium. A magnesium-thermic reaction was used for the synthesis. X-ray examination of the product indicates that the crystalline portion of the composition is a combination of magnesium borides, magnesium silicate, and magnesium orthoborate. Chemical analysis of a representative sample shows, in weight-percent, boron 17.6, silicon 23.9, magnesium 17.8, and chromium 0.5. The balance is largely oxygen. The composition is resistant to high temperatures under oxidizing conditions and is stable in water, hydrochloric acid, and hydrogen. It has a low density (less than 3 grams per cubic centimeter) and a hardness value in the range of quartz. It has a melting point above 1,700°C. and can be hot-pressed to shape in the temperature range between 1,200 and 1,350°C. The properties described indicate that the material may have some uses as a high-temperature refractory, and because of its boron content it may have some value as a thermal-neutron-absorption material. (auth)

18447 (BMI-876(Del.)) WELDED CLOSURES FOR FUEL ELEMENTS. R. P. Sopher, G. E. Martin, G. B. Grable, C. B. Voldrich, A. F. Leatherman, and F. C. Todd (Battelle Memorial Inst., Columbus, Ohio). Oct. 8, 1953. Decl. with deletions Nov. 30, 1959. Contract W-7405-eng-92. 48p.

Inert-gas arc-welding processes were used in weldability studies of aluminum alloys that are considered for use as canning materials. The solid-phase and induction welding processes were also investigated for making can closures. The weld-joint bend ductility of 52S, 63S, 150S, Al-0.20 wt.% Mg, and Al-0.20 wt.% Zr alloys was 31% or greater, compared to 50% or greater ductility for the 2S material. The 63S alloy was more susceptible to cracking during welding under restraint than the other alloys. Weld-joint strengths approaching the strength of the base material were obtained by solid-phase welding. Test welds from induction welding indicated that the process may be adaptable to can welding. (auth)

18448 (BMI-898(Del.)) A STUDY OF THE DIP COATING OF URANIUM SHEET WITH ALUMINUM-SILICON ALLOY. E. W. Cawthorne, C. M. Craighead, W. E. Berry, H. A. Pray, and R. I. Juffee (Battelle Memorial Inst., Columbus, Ohio). Jan. 18, 1954. Decl. with deletions Dec. 1, 1959. Contract W-7405-eng-92. 48p.

A single-dip process for coating uranium sheet with aluminum-12.5 wt.% silicon alloy was developed. The technique consists of directly dipping uranium plate at a rate of approximately 0.6 in. per sec into a molten aluminum-silicon bath for about 15 sec at 585°C. Pretreatment of the slugs consists of sand or vapor blasting, nitric acid etching, and drying. A study of dipping conditions indicated that a minimum thickness of intermetallics is obtained by dipping at 585°C and for the shortest time commensurate with good operation (about 15 sec with 3 × 1 × 0.1-in. specimens). Raising the bath temperature or increasing the immersion time increases the thickness of the brittle intermetallic zone. Additions of copper or magnesium to the bath, which permitted dipping at as low as 570°C, actually increased the thickness of the intermetallic zone. Similarly, small additions, of beryllium, iron, misch metal (cerium and lanthanum), and nickel to the aluminum-12.5 wt.% silicon bath did not reduce the thickness of the intermetallic zones. The ductility of the aluminum-silicon coatings was evaluated by bend tests. Coatings formed at 585°C by 15-sec immersion in the aluminum-silicon bath could be bent over a 1½-in. radius with no evidence of coating failure.* With sharper bends the first evidence of failure was noted in the brittle UAl₃ intermetallic zone. Corrosion tests in boiling water indicate that with optimum conditions an aluminum-silicon coating can be produced which provides considerable protection to the uranium. (auth)

18449 (BMI-1275(Del.)) EXAMINATION OF FACTORS AFFECTING THE QUALITY OF VACUUM INDUCTION-MELTED URANIUM. Roy W. Endebrook, Ellis L. Foster, Jr., and Ronald F. Dickerson (Battelle Memorial Inst., Columbus, Ohio). July 3, 1958. Decl. with deletions Jan. 14, 1960. Contract W-7405-eng-92. 54p.

Uranium melting was investigated to determine what reactions, variable in nature, could be detrimental to ingot purity or soundness. Experiments were conducted with 10-lb uranium charges in a vacuum induction furnace 1200 liters in volume. A special manifold allowed sampling of the furnace atmosphere for mass spectrometer analyses at appropriate times after the furnace was isolated from the vacuum system. Melts were made with a selected production grade of pure uranium. The program included (1) exploratory melts in graphite with and without MgO crucible dressings, (2) melts in graphite and zirconia crucibles under dry and wet furnace conditions, (3) replicate experiments in which known quantities of hydrogen, nitrogen, CO, oxygen, CO₂, H₂O, and argon were each admitted to the furnace to determine pressure-time relations and residual-gas compositions, and (4) a demonstration of the water-gas reaction within the furnace. The MgO crucible dressing tended to peel during initial outgassing. During the melting cycle, MgO was reduced and formed a black magnesium deposit within the furnace. Gases and, especially, water vapor adsorbed by graphite components were difficult to remove. To lower the outgas rate at 2500°F from 3 to 0.45 μ per min, it was necessary to heat the crucible for 5½ hr at 2500 to 3100°F and 10⁻⁴ mm of mercury. Water and graphite at elevated temperatures produced hydrogen and CO, the products of the water-gas reaction. A secondary reaction between CO and uranium resulted in a furnace atmosphere that was mainly hydrogen. Temperature variations between surface and subsurface metal were large. Optical temperature determinations were affected by dross and varied considerably with dross thickness. The integrity of the surface dross was a controlling factor of the composition and amount of reactive gas remaining over the melt and of the ability to reproduce data. From a thermodynamic viewpoint, small changes in CO partial pressure over the melt will result in

large changes in the carbon-oxygen level of the melt, and the contribution of CO to contamination can be greater through this mechanism than by the direct CO-uranium reaction. (auth)

18450 (BMI-1389(Del.)) SURVEY OF END-CAPPING METHODS FOR ZIRCALOY-2-CLAD URANIUM FUEL ELEMENTS. Julius J. Vagi, Roger L. Koppenhofer, and Robert M. Evans (Battelle Memorial Inst., Columbus, Ohio). Oct. 27, 1959. Decl. with deletions Feb. 8, 1960. 19p.

A literature survey was made of brazing and welding methods used to minimize the amount of exposed core material and provide the longest path for corrosion in the event of a defective weld in coextruded Zircaloy-2-clad uranium and U-2 wt.-%-Zr fuel elements. Most brazing information was on filler alloys which melt above the α -to β -phase transformation temperature of the core material. Techniques for welding and/or brazing using the information gathered were explored. A few experimental seals were made to get an idea of the problems encountered. One novel method of end sealing, resistance sintering of a powdered-metal end cap, showed promise in the preliminary experiments. (auth)

18451 (BMI-1512) THE MECHANISM OF PRESSURE BONDING. George W. Cunningham and Joseph W. Spretnak (Battelle Memorial Inst., Columbus, Ohio). Apr. 6, 1961. Contract W-7405-eng-92. 114p.

The pressure bonding of OFHC copper was studied, and the mechanism of the solid-phase bonding of two components under the application of heat and pressure was established. The effects of pressure, temperature, grain size, and surface roughness were evaluated. In OFHC copper the pressure required to place the surfaces in intimate contact is equivalent to the Meyer hot hardness at which the penetration of the indenter is equal to the average depth of the surface asperities. A pressure of 0.59 of the Vickers hot hardness was required to obtain intimate contact for the model studied in detail. The pressure required is inversely proportional to the surface roughness and directly proportional to the number of points of contact raised to the $n-2/n$ power where n is the Meyer coefficient. Grain growth across the bond region was found to be dependent upon the presence or absence of microvoids. At high temperatures the driving force to straighten the irregularly shaped interface was sufficient to provide grain growth across the bond region if there were only a few microvoids. If the number of microvoids was large, grain growth could only occur if the grain size was smaller than the size usually existing at that temperature or if recrystallization or an allotropic transformation occurred during bonding. (auth)

18452 (DEG-Report-300) VACUUM BRAZING WITH A RADIO-FREQUENCY INDUCTION HEATER. J. Leece, J. Bishop, and C. C. McCormick (United Kingdom Atomic Energy Authority. Development and Engineering Group, Capenhurst, Ches., England). Jan. 9, 1961. 23p.

A short study was made of brazing methods *in vacuo* using a radiofrequency induction heater. The absence of flux, together with the reduction of surface oxides and the degassing of the metal that occurs at brazing temperatures, makes any subsequent chemical or mechanical cleaning unnecessary. In this way, a substantial improvement in chemical and physical standards of the finished components as compared with conventional methods can be achieved. An installation is described which is suitable for work up to 4 in. in diameter and 15 in. in height. Some applications are also described which illustrate the wide scope of the technique. (D.L.C.)

18453 (HW-30780(Del.)) EVALUATION OF URANIUM-HYDRIDE COMPACT SLUGS. A. T. Taylor (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Feb. 4, 1954. Decl. with deletions Jan. 26, 1960. 16p.

An investigation was made of uranium compact slugs, manufactured from uranium hydride, to study the properties produced by powder metallurgical techniques. The data indicate that the fineness of grain size and the degree of preferred orientation of the material are superior to standard beta-transformed production metal while the density and cannability of the material compares favorably with standard beta-transformed production metal. (auth)

18454 (HW-68512) FUEL CLOSURES—BRAZE LAYER REACTIONS TRANSMUTATIONS, DIFFUSION, AND COMPOUND FORMATION. S. H. Bush (General Electric Corp. Hanford Atomic Products Operation, Richland, Wash.). Feb. 15, 1961. 10p.

Reactions occurring in the cladding-fuel interfacial zone during irradiation are discussed. It was assumed that braze layers are used to bond the metallic fuel to the end cap. Possible braze materials investigated included Zr-5 wt.-% Be, X-8001 Al, AlSi, and copper. The only nuclear transmutation which appeared to be a problem was that occurring in beryllium contained in the Zr-5 wt.-% Be alloy. The degree of penetration through the cladding and the behavior of the compound layer formed due to diffusion was studied. The predicted penetration values or phase thickness for the various systems are given. The rapid diffusion and high penetrations of aluminum alloys into uranium, coupled with the friability of the UAl_3 compound formed does not favor their use as braze materials. Copper appeared to pose no problem where diffusion or compound formation are concerned. The U-Zr, Al-Zr, and Cu-Zr systems pose no problems in penetration through diffusion and compound formation, providing the initial bond is adequate for fuel element applications. (M.C.G.)

18455 (HW-68892) THE ZIRFLEX DECLADDING OF TUBE-IN-TUBE TYPE FUEL ELEMENTS. P. W. Smith (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Feb. 23, 1961. 11p.

Pilot unit Zirflex dissolutions were carried out on near prototypical tube-in-tube type elements clad in oxidized Zircaloy. The runs were made with the elements horizontal and at simulated large scale operating conditions. No significant difference was noted between the actual decladding achieved in these experiments and that which was predicted from prior studies on similarly oxidized elements with somewhat different geometries. No gas blanketing nor diffusion effects were observed. Initially, preferential attack was noted on areas where oxide film had been scratched or handled. However, near the end of a run a random distribution of undissolved cladding existed; 90% of the cladding was removed in 6.5 hours. (auth)

18456 (INS-26) THE FABRICATION OF THE DISK-LOADED WAVEGUIDE OF THE LINEAR ACCELERATOR BY ELECTRO-FORMING. J. Tanaka, T. Nishikawa, A. Miyahara, K. Kobayashi, M. Aratani, S. Hirata, E. Yamazaki, M. Murata, K. Kondō, S. Ikeda, and M. Kawashima (Tokyo Univ. Inst. for Nuclear Study). Mar. 22, 1961. 25p.

The techniques of electroforming for the copper disk-loaded waveguides of the 6-Mev linear electron accelerator to be used for the injector of the 1-Bev electron synchrotron are described. The structure of the disk-loaded waveguide consists of a hollow round tube and periodically placed

disks. The electroforming procedure consists of the following steps: machining and gold-plating the copper disks, assembly of disks on a jig in water, plating the assembly with copper, etching, cleaning, and machining of the outer wall. (M.C.G.)

18457 (NP-8368) THE SLOW EXTRUSION OF METALS. PART III. M. T. Watkins, K. Ashcroft, and J. McKenzie (Gt. Brit. Mechanical Engineering Research Lab., Glasgow). Dec. 1954. 46p. (MERL-102)

A technique was developed for determining the temperature distribution set up inside a metal slug during extrusion. A study was made of the effects of extrusion method, type of product, reduction, punch speed, slug dimensions, die geometry, and lubrication on the extrusion pressure, the temperature rise, and the deformation pattern produced inside the slug. Rods, tubes, and tubular containers of chemical lead (Grade A), aluminum (99.5% purity), E.R.H.C. copper, and 70/30 brass were extruded at room temperature at punch speeds varying from 1 to 6 inches per minute. All slugs, excepting those used in the study of slug dimensions, were of 1 inch diameter and 1 inch high. The investigation showed that the extrusion pressure was largely influenced by the reduction in cross-sectional area of the extruded product and to a lesser extent only by the remaining variables. The deformation pattern set up in the extruded product was chiefly dependent on the reduction and on die geometry which also had an appreciable effect on the incidence of piping. The major factors contributing to the rise in temperature inside the slug during extrusion were the reduction and the punch speed, the latter presumably governing the amount of heat lost by conduction through the die, the chamber, and the punch. The application of the technique in the study of possible localized temperature effects due to the remaining process variables is being pursued. (auth)

18458 (NP-10003) THE MANUFACTURE OF Ti-7Al-12Zr SHEETS. Bi-Monthly Report IX, December 31, 1960 to February 28, 1961. J. K. Dietzel and S. R. Seagle (Reactive Metals, Inc., Niles, Ohio). Mar. 1961. Contract NOa(s) 59-6229-c. 5p.

Tests conducted on Ti-7Al-12Zr 0.125-in. pilot run production sheet showed that the material had satisfactory properties in both the annealed, and annealed and thermally exposed conditions. One-half of the scheduled number of 0.040- and 0.125-in. sheets was rolled to final gage; and one-half of the scheduled number of 0.063-in. sheets was rolled to breakdown gage (0.155-in.). (auth)

18459 (NP-10117) EXPLOSIVE FORMING OF REFRACTORY METALS. Final Technical Report, June 30, 1959 to September 30, 1960. (Chromalloy Corp., West Nyack, N. Y.). Dec. 31, 1960. Contract NOa(s) 59-6265-c. 101p.

The feasibility of explosively forming refractory metals, particularly molybdenum and Mo- $\frac{1}{2}$ % Ti alloys was investigated. Some testing was performed on niobium and tungsten. The two-die configurations that were chosen for testing the metals provided multi-directional and unidirectional deformation. The program was set up to explore: elongation, metallurgical effects, strain rates, temperature, and explosive joining. (B.O.G.)

18460 (NP-10118) EXPLOSIVE FORMING OF REFRACTORY METALS. Bi-Monthly Report No. 6, June 1, 1960 through July 31, 1960. (Chromalloy Corp., West Nyack, N. Y.). Dec. 1960. Contract NOa(s) 59-6265-c. 9p.

18461 (ORO-399) FUEL-BEARING FIBERGLAS IN ALUMINUM BASE FUEL ELEMENTS. Monthly Progress Letter No. 19, March 1, 1961-March 31, 1961. R. H.

Baskey (Clevite Corp. Mechanical Research Div., Cleveland). Apr. 18, 1961. Contract AT(40-1)-2557. 3p.

Hot pressing of Al-coated U-bearing fiberglass for use as core material is reported. In hot rolling experiments, the effects of varying the cladding thickness were investigated and an experiment was conducted to find the effects of welding completely around composite billets instead of tack welding only the ends. The experimental effort is to be directed toward using 5154 Al or fiberglass-reinforced Al cladding material. (J.R.D.)

18462 (SCNC-311) CERAMIC FUEL ELEMENTS MADE BY HOT ISOSTATIC PRESSING. I. Sheinhart and J. Fugardi (Sylvania-Corning Nuclear Corp., Bayside, N. Y.). Sept. 1960. Contract AT-30-1-GEN-366. 45p.

UO₂ fuel elements clad in stainless steel were prepared by the hot isostatic pressing process. UO₂ powder was consolidated in a stainless steel tube by tamping, sonic or ultrasonic vibrations, and further densified by hot isostatic pressing. Using 100%-fused UO₂ powder and temperatures to 1250°C the density of the cores was 87 to 90% of theoretical. A mechanical bond between the ceramic core and the metal cladding was obtained. (auth)

18463 (TID-11363) PRODUCTION OF MIXED UO₂-ThO₂ OXIDE PELLETS BY SINTERING IN AIR. Quarterly Report No. 1. (Compagnie Industrielle des Combustibles Atomiques Frittés, par Orsay Seine-et-Oise, France). Dec. 15, 1960. EURATOM Contract EUR/C/1356/60 f. AEC 73/Euratom 33. 40p. (Includes original, in French, 31p.).

A description is given of a method for preparing crude pellets. Sintering tests were made in hydrogen (cracked ammonia). The sintering process was accelerated by raising the density in the rough and by adding CaF₂, CaCO₃, or MgO. It was found that the presence of UO₂ generally lowers the density after sintering. Tests were begun for sintering-in-air. (B.O.G.)

18464 (TID-12175) URANIUM OXIDE EXTRUSION (SECOND YEAR). Quarterly Report No. 1. (Compagnie Industrielle des Combustibles Atomiques Frittés, par Orsay (Seine-et-Oise), France). Dec. 15, 1960. EURATOM Contract EUR/3081/60 f. 25p. (Includes original, in French, 17p.). AEC 48/Euratom 37.

Using a uranium oxide powder of average specific surface, extruded rods were fabricated at densities of 10.2 to 10.3 g/cm³, by applying an isostatic pressing operation before sintering. The inclusion of sintered grains in powders of the same specific surface resulted in rods of which the density, after sintering, was practically identical to the density of rods containing no sintered grains. (auth)

18465 (TID-12483) URANIUM OXIDE EXTRUSION. Quarterly Report No. 2. (Compagnie Industrielle des Combustibles Atomiques Frittés, par Orsay Seine-et-Oise, France). Mar. 15, 1960. EURATOM Contract EUR/C/1323/3/59 f. AEC 48/Euratom 37. 27p. (Includes original, in French, 17p.).

Cylindrical revolution rods were fabricated by Rhodoviol extrusion of UO₂ of specific surface area. The influence of the bond type, granulation method, die characteristics, surface layer of the crude rods, and sintering conditions on the densification, appearance, and deformation of the sintered rods were studied. The Rhodoviol extrusion of UO₂ to which, a wetting agent was added, followed by sintering under load, enabled the fabrication of sintered rods. (B.O.G.)

18466 (TID-12484) URANIUM OXIDE EXTRUSION. Quarterly Report No. 3. (Compagnie Industrielle des

Combustibles Atomiques Frittés, par Orsay Seine-et-Oise, France). June 14, 1960. EURATOM Contract EUR/C/1323/59 f. AEC 48/Euratom 37. 39p. (Includes original, in French, 27p.).

18467 (TID-12485) URANIUM OXIDE EXTRUSION. Quarterly Report No. 4. (Compagnie Industrielle des Combustibles Atomiques Frittés, par Orsay Seine-et-Oise, France). Sept. 15, 1960. EURATOM Contract EUR/C/1323/3/59 f. AEC 48/Euratom 37. 22p. (Includes original, in French, 17p.).

18468 (TID-12486) URANIUM OXIDE EXTRUSION. Draft of Final Report. (Compagnie Industrielle des Combustibles Atomiques Frittés, par Orsay Seine-et-Oise, France). [1960?] EURATOM Contract EUR/C/1323/3/59 f. 36p. (Includes original, in French, 23p.). AEC 48/Euratom 37.

Studies were made of the influences of extrusion, preparation of pastes, sintering, and rectification before and after sintering on uranium oxide for obtaining cylindrical, revolution rods 14- to 15-mm diameter, 180- to 260-mm long, and 10- to 10.25-g/cm³ density, with rectified dimensional tolerances of ± 0.05 mm of the diameter and iron equivalent impurities <1500 ppm. The studies led to checking raw materials to measure specific surfaces and O/U ratio. Measurements were made of the bending-strength breaking loads of the extruded rods. Using the semi-bulk method of sintering, followed by rectification, it is shown that the process of shaping by extrusion may be rendered industrial. (auth)

18469 (Y-1301) PRODUCTION, PRECISION FORMING, AND SINTERING OF CERAMIC-GRADE UO_2 . A. J. Caputo and J. E. Perry (Union Carbide Nuclear Co. Y-12 Plant, Oak Ridge, Tenn.). Mar. 16, 1961. Contract W-7405-eng-26. 37p.

A process was developed for the consistent production of high-quality, sinterable UO_2 powder. The precision forming of the powder and sintering of the green compact to a high-density body were also studied. Ammonium diuranate was precipitated from solutions of uranyl fluoride and/or uranyl nitrate and then continuously converted to UO_2 in a rotating kiln. By carefully maintaining control conditions throughout the process, the powder produced had the property of forming green compacts of various shapes at low forming pressures without the use of binders or lubricants. The compacts sintered to a high density (>94% of theoretical) at moderate temperatures while maintaining clean, chip-free surfaces and edges. Close diameter tolerances, ± 0.001 to ± 0.003 inch (depending on size and shape), were met consistently without the use of a grinding operation. This departure from the conventional procedure (use of binders, lubricants, high forming pressures, and grinding to final dimensions) was developed with the aim of lowering production costs of sintered UO_2 shapes. (auth)

18470 (NP-tr-566) ELECTRONIC VACUUM WELDING. Vladimir Horacek, Cyril Chorvath, and Blazena Trefilova. Translated from Zvaranie, 8: 219-21(1959). 11p.

A description is given of the electron-beam welding method which increases the quality of heat-resistant and chemically-active materials for nuclear applications. Particular results are given with a description of the equipment. (auth)

18471 (NP-tr-595) POWDER METALLURGY. I. N. Frantsevich. Translated from "Peroshkovaya Metallurgiya." (A publication of the Publishing House of "Znanie," Moscow, 1958). 94p.

The history of powder metallurgy and its applications are discussed to show the advantages of the process of produc-

tion, the quality of products, and the multiplicity of forms. Attention is focused on the uniqueness of the products and possibilities of solving complicated and urgent problems of modern technology. (auth)

18472 REACTIVE HOT PRESSING OF ZrC-UC SOLID SOLUTION. Paul Stephan and E. W. Hoyt (General Electric Co., Vallecitos Atomic Lab., Pleasanton, Calif.). Am. Ceram. Soc. Bull., 40: 320-3(May 1961).

High density pellets of zirconium carbide-uranium monocarbide solid solutions were made by reactive hot pressing, wherein the proper amounts of ZrC, UO_2 , and graphite powders were placed in a graphite die, allowed to react at about 2000°C in a vacuum or argon, and were then pressed to form the desired ZrC-UC pellet. The addition of 1 wt.% nickel enhanced grain growth, but the nickel did not remain in the final product. (auth)

18473 STUDY ON THE FABRICATION OF THE $BeO-UO_2$ SINTERED BODY BY MEANS OF VACUUM HOT PRESSING. Katsuzo Kida (Nippon Gaishi Kaisha, Ltd., [Japan]), Susumu Nishigaki, and Ryusuo Ueda. J. Atomic Energy Soc. Japan, 3: 200-7(Mar. 1961). (In Japanese)

$BeO-UO_2$ sintered bodies containing 2 to 10 wt% UO_2 were prepared in a graphite mold by hot pressing and induction heating for 60 min at 1,400 to 1,600°C under a compression of 160 kg/cm² in a vacuum of 10^{-3} mm Hg. Under the optimum pressing condition, bodies having the following properties are obtained: density up to 98% of theoretical; bending strength 1,900 to 2,300 kg/cm²; thermal conductivity slightly decreased with UO_2 content down to 0.48 (at 10 wt% UO_2) cal/cm·sec·°C at room temperature; linear expansion the same as BeO sintered bodies. (auth)

18474 PROTECTION OF CARBON AND GRAPHITE FROM OXIDATION AT UP TO 1200°. M. V. Sazonova, A. Ya. Sitnikova, and A. A. Appen (Inst. of Chemistry of Silicates, Academy of Sciences, USSR). Zhur. Priklad. Khim., 34: 505-12(1961). (In Russian)

High-quality vitreous silicon insulators were developed for protecting carbon-graphite materials against oxidation at 1200° for periods over 100 hours. Wettability coating composition, and coat binding are discussed. (R.V.J.)

18475 IMPROVEMENTS IN OR RELATING TO PRESSURE WELDING. Norman Frank Eaton (to United Kingdom Atomic Energy Authority). British Patent 865,821. Apr. 19, 1961.

A method is given for pressure welding a metal end cap to a metal tube. In this method, the tube contains a rod and is supported by a split die. The tube is provided with a frusto-conical end face, and a dished end cap with a frusto-conical face is located on the tube so that the conical faces abut. Welding of the cap to the tube is accomplished by a punch which is forced downward on the cap. (D.L.C.)

18476 METHOD OF BONDING THORIUM WITH ALUMINUM. (to U. S. Atomic Energy Commission). British Patent 866,580. Apr. 26, 1961.

A process is described for bonding Al to Th by hot isostatic pressing. Clean surfaces of commercially pure Al and reguline Th are pressed together for at least 2 min at 375 to 575°C and at a pressure greater than 5 tsi. Best results are obtained by pressing from 2 to 30 min at 500 to 575°C and at 10 to 20 tsi. (T.F.H.)

Properties and Structure

18477 (AEEW-R-38) MEASUREMENT OF THE SPECIFIC HEATS OF SANTOWAX 'R', PARA-, META- AND ORTHO-TERPHENYL, DIPHENYL AND DOWTHERM 'A'.

R. W. Bowring, D. A. Garton, and H. F. Norris (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Establishment, Winfrith, Dorset, England). Dec. 1960. 37p.

Measurements were made of the specific heats of Santowax-R, terphenyl isomers, diphenyl, and Dowtherm-A, using an adiabatic calorimeter. The specific heats were found to increase linearly with temperature, the slope being substantially the same for all the pure materials except p-terphenyl. The specific heat of Santowax-R was $\sim 1/2\%$ less than the weighted mean of its components. The probable accuracy of the measurements was $\pm 2\%$, which was confirmed by comparison with diphenyl ether. (auth)

18478 (AFCRL-4) LITERATURE SURVEY OF SELECTED SEMICONDUCTOR PROPERTIES. Scientific Report No. 1. Richard W. Sullivan, Richard D. Seibel, and Charles E. Lundin (Denver. Univ. Denver Research Inst.). Dec. 1, 1960. Contract AF19(604)-7222. 60p.

A literature survey was conducted for selected thermodynamic data of semiconductor materials. The data are given, with respective references, as follows: thermodynamic properties of Groups II-A, III-B, IV-B, and V-B elements; thermodynamic properties of intermetallic compounds between Groups II-A and IV-B, and III-B, and V-B elements; and distribution coefficients and solid solubilities of solute elements in silicon and germanium. 44 references. (auth)

18479 (ASC-TR-7-882(II)) HIGH ENERGY RATE EXTRUSION. Interim Technical Progress Report No. 2, Phase 2, January 1, 1961-March 31, 1961. G. A. Reimann (Westinghouse Electric Corp. Materials Manufacturing Dept., Blairsville, Penna.). Contract AF33(600)-41948. 10p.

The first set of extrusion tooling is described and illustrated, the materials for extrusion are listed, and the proposed methods of Dynapak instrumentation are discussed. (auth)

18480 (BM-RI-5709) HIGH-TEMPERATURE HEAT CONTENT OF URANIUM TETRAFLUORIDE. E. G. King and A. U. Christensen (Bureau of Mines. Berkeley Thermodynamics Lab., Berkeley, Calif.). July 1960. 4p.

Measurements of heat content of UF_4 were made at 298 to 1350°K. The melting point and heat of fusion were determined. The results are tabulated, and representative heat-content equations are included. (auth)

18481 (BM-RI-5770) PREPARING ZIRCONIUM DIBORIDE DIRECTLY FROM ZIRCON. Perry G. Cotter (Bureau of Mines. Norris Research Lab., Norris, Tenn.). June 1960. 9p.

The synthesis is based on the reaction $2ZrO_2 \cdot SiO_2 + B_4C + 5C \rightarrow 2ZrB_2 + 2SiO + 6CO$. Charges consisted of 76% zircon, 13% B_4C , and 11% lampblack. The optimum conditions for synthesis were determined by heating at 1200 to 1700°C, under a starting vacuum of 50μ for 10 min to 12 hr. The reaction began at $1350 \pm 25^\circ C$ and continued when the application of heat was discontinued. The quality of the product was found comparable to commercially produced ZrB_2 . The quantities of residual carbon and SiO_2 are not excessively high, but refinements in procedure may lower the amounts. (B.O.G.)

18482 (BMI-1513) HIGH-TEMPERATURE NIOBIUM-BASE ALLOYS FOR SODIUM-COOLED REACTORS. John A. DeMastry, Frederick R. Shober, and Ronald F. Dickerson (Battelle Memorial Inst., Columbus, Ohio). Apr. 14, 1961. Contract W-7405-eng-92. 30p.

In work to develop fuel-element cladding material for the EBR-II, binary Nb alloys containing 2.37 wt.% Cr, 3.34 wt.%

Zr, or 5.21 wt.% V and a ternary alloy containing 1.56 wt.% Zr and 1.09 wt.% Cr were fabricated by forging at 550°C and rolling to sheet or by rod rolling at 1200°C in a stainless steel can. All four alloys were completely recrystallized after 90% cold work (reduction in thickness) and a 1-hr. anneal at 1149°C. Tensile tests on the annealed materials at 650, 800, 1000, 1150, and 1315°C indicated that Cr, Zr, and V are potent strengtheners of Nb: the 2.37 wt.% Cr alloy had a 0.2% offset yield strength of 38,000 psi at 1000°C, and the 5.21 wt.% V alloy had a yield strength of 38,300 psi. At 1315°C, the 3.34 wt.% Zr alloy had a 0.2% offset yield strength of 14,700 psi; the 1.56 wt.% Zr-1.09 wt.% Cr alloy had a yield strength of 13,500 psi at 1315°C. Stresses to produce creep rates of 0.001, 0.01, and 0.1% per hr. were determined for the binary alloys at 650, 800, and 1000°C. The V alloy exhibited the greatest creep resistance, requiring stresses of 52,700, 40,000, and 15,500 psi to produce a creep rate of 0.001% per hr. at 650, 800, and 1000°C, respectively. (auth)

18483 (BMI-X-168) EVALUATION OF FATIGUE CHARACTERISTICS OF HASTELLOY-X TUBING AT ELEVATED TEMPERATURES. A. R. Duffy, G. M. McClure, and H. J. Grover (Battelle Memorial Inst., Columbus, Ohio). Apr. 30, 1961. 37p.

The fatigue performance of 0.25-in. diam. Hastelloy-X tubing from two different sources was studied at 1400, 1600, 1800, and 2000°F for stress ratios of 0.25, 0.95, and ∞ . A cyclic test speed giving 10^5 cycles/hr was used, and the results are displayed in the form of Goodman diagrams. The maximum stress required to cause failure at 10^6 cycles was also determined. The microstructures of individual tubing batches were examined. Several questions relative to the metallurgical and fatigue performance are discussed, and several tentative conclusions are given. (D.L.C.)

18484 (CEA-Note-D-16) ESSAI COMPARATIF DE RADIOGRAPHIES DIRECTES DE BARRES D'URANIUM TRES REFOIDIES ET DE BARRES D'URANIUM TRES CHAUDES. (Comparative Analysis of Very Cold and Very Hot Uranium Bars by Direct Radiography). P. Delattre and J. Lalere (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Saclay). Mar. 1958. 14p.

Direct radiographic examinations were made of three natural uranium fuel assemblies from EL-2 and one enriched fuel element from EL-2. The radiographic films obtained for each rod are shown. (J.S.R.)

18485 (DMIC-Memo-104) REVIEW OF RECENT DEVELOPMENTS IN THE TECHNOLOGY OF NICKEL-BASE AND COBALT-BASE ALLOYS. D. A. Roberts (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). May 5, 1961. 6p. (PB-171623)

Recent developments in Ni-base and Co-base alloys and high-strength superalloys are reviewed briefly. Research on these alloys appear to be directed along three channels: (1) development of new alloys with improved properties, (2) development of dispersion-hardened alloys by powder metallurgy techniques, and (3) determination of the properties of existing materials. (D.L.C.)

18486 (DMIC-Memo-105) REVIEW OF RECENT DEVELOPMENTS IN THE METALLURGY OF BERYLLIUM. Webster Hodge (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). May 10, 1961. 6p. (PB-171624).

A brief summary on recent developments in beryllium metallurgy is presented with emphasis on purity and mechanical and physical properties. The summary is based

on reports and publications received during the period Feb. 1 to April 30, 1961. (D.L.C.)

18487 (DPST-54-525) REDUCTION OF UO_2 BY ALUMINUM. W. W. West (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Nov. 12, 1954. Decl. Mar. 22, 1961. 7p.

Reduction of UO_2 by aluminum was observed after heating both above and below the melting point. Reactions other than reduction may have taken place which misled interpretation of metallographic and x ray examination. The smaller particles were reduced faster than the larger particles. Hot working initiated reduction in the ORNL compacts, and accelerated the reduction rate on subsequent heating. Oxide contents to 15% in the compact had no apparent effect on the reduction rates. (auth)

18488 (GAMD-304) FISSION PRODUCT TRAPS FOR USE IN HIGH-TEMPERATURE GAS-COOLED GRAPHITE REACTORS. L. R. Zumwalt (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Mar. 13, 1958. Contract AT(04-3)-314. 15p.

A proposal is given of an approach to a fission-product trapping system which appears feasible on the basis of thermodynamic and other data available. Reactor and trapping conditions are outlined. The half-lives, fission yields, and volatility of the fission products of interest are described. To provide the most effective retention at elevated temperatures, two types of reagents are required: a highly electropositive metal that will not melt or appreciably vaporize and which will form stable non-volatile compounds with non-metallic or near non-metallic fission products; and a reagent to provide a highly electronegative element to form stable, non-volatile compounds with metallic fission products. Thermodynamic properties are included for compounds formed by reactions between the fission products and the trapping reagents. (B.O.G.)

18489 (GAMD-1769) THE STABILITY AND PROPERTIES OF ALLOY STEELS AT ELEVATED TEMPERATURES. A LITERATURE SURVEY. M. T. Simnad (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nov. 21, 1960. 80p. Project No. 32. Contract AT(04-3)-314.

A survey was made of the information that is available on the formation of the sigma phase and its effects on the properties of stainless steels. Excerpts were gathered from various journals and monographs and are presented under the following headings: crystal structure and phase equilibria, identification, effects on mechanical properties, effects on welds, and corrosion resistance. It was concluded from these studies that great care must be exercised in the choice of the type of stainless steel to be used for very long periods of time at elevated temperatures. (M.C.G.)

18490 (GAMD-2101) MELTING POINTS AND THERMODYNAMIC PROPERTIES OF SOME REACTOR CORE MATERIALS. S. Langer (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Mar. 20, 1961. Contract AT(04-3)-314. 22p.

The data presented include: melting points of borides and carbides, and eutectic and peritectic temperatures in binary systems of interest to the HTGR program; free energies of formation and vapor pressures of some borides and carbides; and vapor pressures of some metals. (B.O.G.)

18491 (HW-26867(Del.)) GRAPHITE SURFACE STUDIES. C. N. Spalaris (Hanford Works, Richland, Wash.). Oct. 10, 1952. Decl. with deletions Feb. 18, 1960. Contract W-31-109-eng-52. 26p.

An apparatus was constructed for surface studies which employs the Brunauer, Emmett, and Teller method. Nitrogen absorption and desorption isotherms are used to determine the surface area and pore-size distribution of graphite. Surface characteristics of virgin and irradiated artificial graphites and the changes which occur upon irradiation are discussed. (auth)

18492 (LA-2475) CALCULATIONS OF THE COEFFICIENTS OF VISCOSITY, DIFFUSION, AND THERMAL CONDUCTIVITY FOR DISSOCIATING HYDROGEN FOR A RANGE OF TEMPERATURES AND PRESSURES. David G. Clifton (Los Alamos Scientific Lab., N. Mex.). Nov. 1960. Contract W-7405-eng-36. 54p.

The coefficients of viscosity and thermal conductivity for dissociating hydrogen gas were computed for the temperature range from 1500 to 5000°K and seven pressures from 0.1 to 100 atmospheres. The coefficient of diffusion in a binary mixture of the H- H_2 system and the coefficient of self-diffusion for H atoms and H_2 molecules were computed for the same set of conditions. (auth)

18493 (LM/TAB-17) LIQUID METALS TECHNOLOGY ABSTRACT BULLETIN, FOR THE PERIOD OCTOBER 1960 TO APRIL 1961. (MSA Research Corp., Callery, Penna.). 20p.

An annotated bibliography is presented consisting of 40 references to liquid metals technology. Chemical Abstracts and Nuclear Science Abstracts references are included. (B.O.G.)

18494 (NAA-SR-5893) DIFFUSION OF BERYLLIUM IN BERYLLIUM OXIDE. PART II. S. B. Austerman (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). May 1, 1961. Contract AT-11-1-GEN-8. 32p.

The diffusion coefficient for Be in BeO was measured as a function of temperature for a group of identical polycrystalline BeO samples, as well as in a variety of types of BeO samples. The temperature dependence follows two straight lines on a log D-1/T graph, the lines intersecting at 1725°C. The lines correspond to the equations: $D = 1.37 \exp(-91.9 \text{ kcal/mole})/RT$ (1550 to 1725°C), and $D = 1.10 \times 10^{-6} \exp(-36.15 \text{ kcal/mole})/RT$ (1725 to 2000°C). The diffusion coefficient at 1800°C for this particular set of samples is approx. 40 times less than that for a different type of BeO, as previously published. The significance of certain material parameters is considered; no correlation is noted between the magnitude of the diffusion coefficient and any single parameter. The observed wide variations in D (a maximum of 40× at 1800°C) are probably the net result of simultaneous changes in many of the significant parameters of the polycrystalline samples. Lattice diffusion is the inferred principal mode of diffusion in all cases. (auth)

18495 (NDA-2162-1) CARBIDE FUEL DEVELOPMENT. Progress Report, Period of September 15, 1960 to January 31, 1960. A. Strasser (Nuclear Development Corp. of America, White Plains, N. Y.) and K. Taylor (Carborundum Co., Niagara Falls, N. Y.). Feb. 28, 1961. Contract AT(30-1)-2303. 13p.

Several UC batches were synthesized in a graphite resistance furnace in a plutonium glove box. Use of Ni as additive was found to lower the sintering temperature but not the ultimate density of UC. In the fuel-clad compatibility tests, UC was held in contact with various cladding materials at 820°C in helium; the cladding materials included Inconel X, type 304 stainless steel, 2 1/4 Cr-Mo, Be, and Zircaloy 2. The results of microprobe analysis of the compatibility samples after testing for 1000 to 4000 hr are described. UC samples clad by Nb and type

316 stainless steel were irradiated and the helium gap thermal conductivities given for burnups of 3000 and 5000 Mwd/t. (D.L.C.)

18496 (NP-9991) STUDY AND APPLICATION OF SILICON NITRIDE AS A HIGH TEMPERATURE MATERIAL. N. L. Parr, G. F. Martin, and E. R. W. May (Gt. Brit. Admiralty Materials Lab., Poole, Dorset, England). Jan. 1959. 35p. (A/75(S))

The need for an engineering material with good mechanical properties and stability for service in gas turbines at 1200°C led to the study and development of silicon nitride. The material, although brittle at room temperature, has excellent oxidation resistance, comparatively good thermal shock resistance, and adequate creep strength at the temperatures involved if stiffened with a very fine dispersion of silicon carbide which may be incorporated during the reaction sintering production process. Methods for producing the material in suitable form, and in the best physical state for engineering designs, were evolved, and the properties of the material were explored by laboratory evaluation and field trials. If the characteristics of the material are considered during its application, it will provide a much needed and valuable contribution to the presently available high temperature materials. Its usefulness promises to extend far beyond the applications originally envisaged. Some of the fields of application are described and others suggested. (auth)

18497 (NP-10041) OXIDE THERMOELECTRIC MATERIALS. Bi-Monthly Progress Report No. 1, February 2–April 1, 1960. (General Ceramics. Div. of Indiana General Corp., Keasbey, N. J.). Contract NObs-78414. 13p.

Activities are reported in a program to develop and evaluate materials for use in thermoelectric power generators at 1200° or higher. Preparation procedures for mixed valency semiconductors such as $\text{Li}_2\text{O}-\text{NiO}$ and $\text{Li}_2\text{O}-\text{CoO}$ systems are described. Data are included for these compounds on their d-c resistivity and Seebeck coefficients at room temperature to 1200°C. (J.R.D.)

18498 (NP-10042) OXIDE THERMOELECTRIC MATERIALS. Bi-Monthly Progress Report No. 2, April 2–June 1, 1960. (General Ceramics. Div. of Indiana General Corp., Keasbey, N. J.). Contract NObs-78414. 10p.

A description is given of work performed on the development of fabrication procedures for thermoelements, and on measurements of Seebeck coefficients and the d-c resistivity of $\text{La}_2\text{O}_3-\text{SrO}-\text{Fe}_2\text{O}_3$ compounds. Data are presented graphically. (J.R.D.)

18499 (NP-10066) INVESTIGATION OF DUCTILE CERAMICS. Progress Report for the Period April 8, 1960–January 7, 1961. T. H. Hazlett (California. Univ., Berkeley. Inst. of Engineering Research). Contract Noas59-6056-C. 7p.

Activities during the period were devoted to purification of the lithium fluoride starting material, development of procedure and equipment for extrusion, mechanical testing, and sample preparation for electron microscopy and metallography. Considerable emphasis was placed on exploration of the extrusion variables temperature, pressure, and die geometry and upon reduction of contamination and extrusion friction. (J.R.D.)

18500 (NP-10100) PROGRESS REPORT NO. 11, January 1, 1961–March 31, 1961. J. F. Andrew, J. Distant, N. Juul, and H. E. Strauss (Buffalo. Univ.). Apr. 13, 1961. Contract AF33(616)-7791. 32p.

Results of studies on the variation in room-temperature Young's modulus with heat treatment are reported for Pitch-impregnated carbon rods. Heating and cooling curves for

the dependence of the Young's modulus on temperature as the sample is consecutively heat treated to higher temperatures are presented. Other data on thermal conductivity and thermal diffusivity are also given. (J.R.D.)

18501 (NP-10107) THERMAL PROPERTIES OF INDIUM. Technical Report No. 2. Alexis I. Kaznoff, Raymond L. Orr, and Ralph Hultgren (California. Univ., Berkeley. Materials Research Lab.). Apr. 1, 1961. Contract Nonr-222(63). 83p.

True heat capacity of high-purity indium was measured at 350 to 800°K. The high values of this thermodynamic property near the melting point (429.2°K) had the appearance of λ -like transitions associated with higher order changes of state. The premelting increase in heat capacity was caused by the anharmonic effects expressed by the dilational term $C_p - C_v$ and to a smaller degree to the presence of equilibrium point defects. Both effects increase with temperature, the latter being exponential in character. The resulting C_v was found close to the classical 3R value. The development of the equation of state for the volumetric behavior of indium showed that C_v^0 (i.e., C_v where the volume is that corresponding to $T = 0$, $P = 0$) decreases linearly with temperature below the classical value as predicted by theory. The possibility of a phase transformation, other than fusion, was ruled out on the basis of measurements of electrical resistivity, transverse and longitudinal sonic velocities, and x-ray data. The process of fusion in indium was identified as a first order transition from the pressure variation of the melting point. The effect of impurities and grain size on the pre-melting phenomena were shown to be minor. The data obtained from sonic velocities indicated that the shear modulus of indium does not decrease according to Sutherland's law, but in line with the conclusions of Bordoni on lead and tin. The sonic velocities decrease approximately linearly with temperature, and the compressibility increases with temperature. The results of electrical measurements were used as a check on the existence of phase transformation and to obtain the energy of formation of vacancies in indium, which was 5500 calories. The sharp decrease in the high heat capacity values near the melting point may indicate the break-down of clusters in the liquid. Since electrical resistivity measurements and ultrasonic measurements by Kleppa failed to indicate any abnormalities near the melting point, it is surmised that fractional crystallization may have occurred on the rough surface of the molybdenum crucible. The specific heat of liquid indium from a few degrees above the melting point to 800°K is a slowly decreasing linear function of temperature. (auth)

18502 (NP-10111) CERAMIC TUBE REFINEMENT. Scientific Report No. 8, July 1, 1960–September 30, 1960. Bruce Barnaby (Eitel-McCullough, Inc., San Bruno, Calif.). Contract AF33(600)-36699. 30p.

A description is given of work accomplished on the getter evaluation and outgassing investigations. The apparatus for measuring gettering rates and capacities by the volumetric method is discussed. Data are presented on the gettering ability of CerAlloy 400 for: CO_2 , CO, and H_2 up to 550°C. The same data taking cycle was repeated with the getter held at room temperature to determine the pumping effect of the ion gage and the evaluation tube. It was found that the pumping effect is appreciable for all the gases investigated. The difficulty of characterizing the gettering ability of CerAlloy 400 at elevated temperatures is described and a possible method is proposed. The progress of the outgassing investigation is discussed particularly with respect to the sample tube. (auth)

18503 (NP-10124) PRESSURE DEPENDENCE OF THE HALL CONSTANT OF THE ALKALI METALS. Technical Report HP-6. Thomas Frederick Deutsch (Harvard Univ., Cambridge, Mass. Gordon McKay Lab. of Applied Science). July 1, 1960. Contract Nonr-1866(10). 116p.

The distortion of the Fermi surface of the alkali metals by pressure was studied by measuring the Hall voltage in the alkalis as a function of hydrostatic pressure up to 15,000 kg/cm². In each case the Hall voltage decreases with increasing pressure, the size of the decrease ranging from 2 to 37% at 15,000 kg/cm² for Li and Cs, respectively, before compressibility corrections are applied. The Hall constant R can be written as $1/Necn^*$ where n^* expresses the deviation from the free electron value of the Hall constant. In all of the alkalis except cesium, n^* decreases monotonically with increasing pressure; the decreases range from 5 to 8% at 15,000 kg/cm² for Li and Rb, respectively. In the case of Cs, n^* passes through a minimum at 5,000 kg/cm² and rises to a value of 1.2 at 15,000 kg/cm². The change of n^* between room and liquid nitrogen temperatures was also measured and found to be less than 3% for all the alkalis except Li. In Li, n^* decreases by ~25%. The pressure results are explained in a semi-quantitative manner using a scattering time that varies by a factor of 3 over the Fermi surface. The warping of the Fermi surface is small; with the exception of Cs, the electron wave vector at the Fermi surface deviates from the free electron value by less than 10%. An approximate expression for the anisotropic scattering time $\tau(k)$ is derived and the factors contributing to the anisotropy in τ are considered. (D.L.C.)

18504 (NP-10146) COMPATIBILITY OF MATERIALS WITH HIGH TEMPERATURE POTASSIUM FIRST QUARTERLY PROGRESS REPORT MAY 1 THROUGH JULY 31, 1960. (Rocketdyne Div., North American Aviation, Inc., Canoga Park, Calif.). Aug. 31, 1960. Contract NAS 5-453. 35p. (R-2617-1)

Several preliminary static capsule tests were made at 2000°F using Hastelloy X as capsule material and He as internal atmosphere. The results for the Nb-Al₂O₃ compatibility test run for 350 hr revealed a hardness increase and a small surface layer formed on the Nb tab. Results for the Nb-K compatibility test run for 25 hr indicated a slight weight loss in the wrought Nb tab amounting to 0.83 and 1.43 mg/cm² day, and metallographic examination revealed no discernible attack on either Nb or Hastelloy X by K. Dynamic capsule and loop equipment for future compatibility studies and mechanical property tests to be used are described. (D.L.C.)

18505 (NP-10147) COMPATIBILITY OF MATERIALS WITH HIGH TEMPERATURE POTASSIUM THIRD QUARTERLY PROGRESS REPORT NOVEMBER 1, 1960 THROUGH JANUARY 31, 1961. (Rocketdyne Div., North American Aviation, Inc., Canoga Park, Calif.). Mar. 3, 1961. Contract NAS 5-453. 62p. (R-2617-3)

Fabrication of loop equipment for studies of compatibility between Nb-1% Zr and liquid K is described. Results of a low-temperature loop run are presented for Ta, Nb, Nb-1% Zr, and Mo, with Mo showing the least change. Results are also presented for bi-metal couples in K (Nb and Nb-1% Zr) and for Nb alloy capsules. (D.L.C.)

18506 (ORNL-3093) IN-PILE MEASUREMENT OF THE ELECTRICAL RESISTIVITY AND THERMOELECTRIC POWER OF SINTERED UO₂. M. D. Karkhanavala and R. M. Carroll (Oak Ridge National Lab., Tenn.). May 2, 1961. Contract W-7405-eng-26. 12p.

Two thin plates of high-density UO₂ were sandwiched together with thermocouples between them and pressed

against the outer surfaces. The thermocouples were used as electrodes and the electrical resistivity of the UO₂ measured by the potential drop method using corresponding arms of the thermocouples as current lead-in wires and potential probes. The UO₂ was heated by its own fission heat and the electrical resistivity measured at temperatures from 50 to 972°C. Preirradiation measurements were made using an electric furnace to obtain temperatures to 750°C. Electrical resistivity did not change with irradiation up to about 10¹⁸ nvt, at which point the resistivity decreased by a factor of 3. The resistivity ranged from 8.75×10^3 ohm-cm at room temperature (before irradiation) to 0.4 ohm-cm at 773°C (after nvt > 10¹⁸). The activation energy was 0.5 eV during irradiation as compared with 0.65 eV before irradiation. The temperature between the plates was higher than the outside temperature during irradiation. This thermal gradient created a thermoelectric emf between the UO₂ and the platinum thermocouples. The thermoelectric emf for the Pt-UO₂-Pt system ranged from 130 μ V/°C at 162°C to 29 μ V/°C at 900°C. The UO₂ behaved like an n-type conductor during irradiation. (auth)

18507 (ORNL-3107) CONCENTRATION OF SETTLED BEDS OF THORIA SLURRY. D. M. Eissenberg (Oak Ridge National Lab., Tenn.). May 2, 1961. Contract W-7405-eng-26. 28p.

The variation in concentration of settled beds of flocculated aqueous suspensions of thoria was studied experimentally as a function of the calcination temperature and particle size of the thoria, the temperature and initial concentration of the suspension, and the concentration of added chromic acid. Values of the ultimate settled-bed concentration were obtained by several methods. Dilatant-plastic behavior of one suspension was considered responsible for the formation, in long vertical tubes, of intractable plugs. (auth)

18508 (RAD-SR-19-60-66) DETERMINATION OF THE THERMODYNAMIC PROPERTIES OF SEVERAL REFRACTORY COMPOUNDS. Quarterly Progress Report No. 1, May 1 to August 1, 1960. S. Bender, T. H. Einwohner, R. Dreikorn, R. E. Gannon, P. L. Hanst, M. E. Ihnat, P. Jahn, T. Licht, J. Phaneuf, S. Ruby, H. L. Schick, R. Walters, and A. Wise (Avco Corp. Research and Advanced Development Div., Wilmington, Mass.). Aug. 12, 1960. Reprinted Jan. 25, 1961. Contract AF33(616)-7327. 96p.

About 1,000 references on the thermodynamic properties of a limited number of refractory materials (oxides, carbides, nitrides, and borides of elements in groups IIA, IVB, VB, VIB, VIIB, plus Sc, Os, and Si) were uncovered, and an author bibliography of 730 of these references is presented. Procedures for searching the literature and processing the data are described. Eighteen compounds for which there is little thermodynamic data available were obtained and/or prepared and analyzed, and equipment for enthalpy and heat capacity determinations are discussed. Heat capacity data are presented for Ti nitride, Ta carbide, and Nb carbide at temperatures varying from 3031 to 4120°F. (D.L.C.)

18509 (TID-7604(p.125-40)) THE PHYSICAL-PROPERTY REQUIREMENTS OF REFRACTORY MATERIALS FOR HIGH-SPEED, HIGH-TEMPERATURE DRY RUBBING-CONTACT SHAFT SEALS AND BEARINGS. C. M. Allen (Battelle Memorial Inst., Columbus, Ohio).

Research was carried out to establish the existence of hot spots during high-temperature, high-speed sliding contact of refractory materials in an evaluation of their performance as shaft seals. Previous studies showed that ma-

materials possessing high thermal-shock resistance performed better in high-speed, high-temperature sliding contact. A special statistical property-material matrix experiment was designed for further evaluation of the significance of individual bulk physical properties. The wear rate on the two materials appeared to decrease (1) with a decrease in the coefficient of friction, (2) an increase in the thermal-stress-resistance factor, (3) an increase in thermal conductivity, (4) a decrease in the heat capacity per unit volume, and (5) as the lower of the thermal diffusivities of the two mated materials increased. (M.C.G.)

18510 (TID-12298) AN ELECTRON MICROSCOPE INVESTIGATION OF ALLOTROPIC TRANSFORMATIONS IN METALS. Henry M. Otte (RIAS, Div. of Martin Co., Baltimore). Mar. 1961. Contract AT(30-1)-2531. 74p.

Thinned samples of a commercial steel and two high-purity stainless steels were examined by transmission electron microscopy. Aspects of thinning techniques by electropolishing are considered. Photomicrographs show a number of alloy features, including the appearance of the bcc martensite, and the hcp epsilon phase. For the transformation of fcc austenite to bcc martensite, a theoretical analysis is given to demonstrate that if the correct variants of the habit plane and orientation relation are known, then the elements of the inhomogeneity pattern can be calculated without requiring a knowledge of the lattice parameter ratios. If the latter are known, then, in addition, two dilatation parameters may be determined. (auth)

18511 (TID-12369) THE DETERMINATION OF THE EQUILIBRIUM PHASE DIAGRAM, ZIRCONIUM-NIOBIUM. Interim Report No. 1. Ronald H. Cox and Charles E. Lundin (Denver. Univ. Denver Research Inst.). Aug. 1960. 55p. Contract AT(11-1)-752.

A systematic determination of the complete equilibrium phase diagram of the binary system, Zr-Nb, was conducted. The phase relationships were determined by metallographic techniques with the auxiliary aid of hardness determination and incipient-melting techniques. A minimum in the liquidus-solidus boundaries occurs at 22 wt.% Nb and 1740°C. Complete solid solubility exists above 970°C in the body-centered cubic phase. A monotectoid reaction exists at 20 wt.% Nb and 610°C. Solid solubilities at the monotectoid level are 0.6 and 85 wt.% Nb, respectively. (auth)

18512 (TID-12479) THE IMPROVED SINTERING OF URANIUM OXIDE WITH A VIEW TO INCREASING ITS THERMAL CONDUCTIVITY. Quarterly Report No. 1. (Compagnie Générale de Télégraphie Sans Fil, Paris). June 29, 1960. EURATOM Contract C/17/60. EURATOM/U.S.A. Agreement Proposal No. 34. AEC 74/Euratom 34. 60p. (Includes original, in French, 41p.).

A review was conducted of the properties of CaO, BaO, CeO₂, La₂O₃, Y₂O₃, and Nb₂O₅ with particular attention to their use in solution, and parameters for bonding to UO₂ in solid solutions and in stoichiometric compounds. Data on thermal conductivity of UO₂ without additives are included. (J.R.D.)

18513 (TID-12480) IMPROVING THE SINTERING OF URANIUM OXIDE WITH A VIEW TO INCREASING ITS HEAT CONDUCTIVITY. Quarterly Report No. 2. (Compagnie Générale de Télégraphie Sans Fil, Paris). Sept. 26, 1960. EURATOM Contract C/17/60. EURATOM/U.S.A. Agreement Proposal No. 34. AEC 74/Euratom 34. 17p. (Includes original, in French, 10p.).

Activities during the period were mainly devoted to preparation of sintered UO₂ samples with and without additives.

Procedures and apparatus for physical measurements of the sintered samples are described. (J.R.D.)

18514 (TID-12481) PERFECTING THE SINTERING OF URANIUM OXIDE WITH A VIEW TO INCREASING ITS THERMAL CONDUCTIVITY. Quarterly Report No. 3, September 15-December 15, 1960. (Compagnie Générale de Télégraphie Sans Fil, Paris). Jan. 5, 1961. EURATOM Contract C/17/60. EURATOM/U.S.A. Agreement Proposal No. 34. AEC 74/Euratom 34. 31p. (Includes original, in French, 26p.).

Program activities during the period were centered around the fabrication of uranium oxide samples which were sintered with and without additives, densitometric and spectrographic examinations, and physical measurements including thermal conductivity and microhardness. (J.R.D.)

18515 (TID-12630) THE PLUTONIUM-ZINC PHASE DIAGRAM FROM 65 TO 100 ATOMIC PER CENT ZINC. E. Daniel Albrecht (Los Alamos Scientific Lab., N. Mex.). 1961. 127p.

Thesis submitted to Univ. of Arizona.

The Pu-Zn phase diagram was investigated over the range of 65 to 100 at.% Zn. Metallographic and x-ray diffraction methods were used to examine specimens of each of the four compounds, PuZn₂, Pu₂Zn₃, PuZn₅, and Pu₂Zn₁₇, found in this system. Extended heat treatments were made at temperatures from 324 to 817°C on single and multiple phase alloys, which were then examined by the same metallographic and x-ray techniques. The melting points of the two compounds PuZn₂ and Pu₂Zn₃ were determined. The liquidus was established over the range of 66.6 to 98.8 at.% Zn and the eutectic composition was redetermined. (auth)

18516 (TID-12725) THE STABLE ATOMIC CONFIGURATIONS FOR AN INTERSTITIAL IN COPPER. K. H. Bennemann (Illinois. Univ., Urbana). 1959. Contract AT(11-1)-182. 7p.

The various stable atomic configurations, formation energies, and changes in volume of the crystal for an interstitial in Cu were calculated with a digital computer. (J.R.D.)

18517 (WADD-TR-60-275) HYDROGEN EMBRITTLEMENT OF TITANIUM ALLOYS. A. E. Riesen and D. H. Kah (Wright Air Development Div. Materials Central, Wright-Patterson AFB, Ohio and Detroit Testing Lab., Inc., Detroit). Oct. 1960. Contract AF33(600)-34083. 48p.

The effect of various hydrogen interstitial contents between 60 and 312 ppm on the notch sensitivity and low strain rate embrittlement of four titanium alloys was investigated at room temperature. The materials investigated included the alpha-beta alloys Ti-6Al-4V, Ta-2Al-6Mo, and Ti-2.5Al-16V, and one all alpha alloy, Ti-5Al-2.5Sn. An optimum embrittling effect was encountered at 180 to 220 ppm hydrogen content in the alpha-beta alloys. Over the range of hydrogen content investigated the alpha alloy was not appreciably embrittled. (auth)

18518 (WAL-TR-11.1/1) A METHOD FOR DETERMINING THE PLASTIC FLOW PROPERTIES OF SHEET AND ROUND TENSILE SPECIMENS. John Nunes and Frank R. Larson (Watertown Arsenal Labs., Mass.). Mar. 1961. 24p. (PB-171560)

An experimental procedure is described for obtaining continuous load-profile measurements of sheet and round tensile specimens during plastic flow. Data obtained on tempered alloy steel, titanium, 301 stainless steel, and an aluminum alloy are presented. With the procedure it was possible to obtain the following data from a single test

curve: true stress-strain, true strain rate, mechanical anisotropy, and "corrected" flow stress. Tests were conducted primarily at room temperature on sheet material with some low temperature tests conducted on the 301 stainless steel. (auth)

18519 (WAPD-BT-22(p.71-7)) EVALUATION OF VITON AND OTHER NONMETALLIC GASKETING MATERIALS IN CONTACT WITH STRUCTURAL ALLOYS. R. E. Moore and E. Rau (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

Highly stressed crevice specimens of austenitic stainless steels in contact with Viton-A and -B elastomers were found to stress-corrosion crack in aerated water at 400°F and above. The stress corrosion cracking is ascribed to the appreciable thermal degradation of the Vitons in high-temperature water with the release of acidic fluorides (stress corrosion agent) as decomposition products. Viton appears limited to water temperatures of 250°F and below, Buna-N could be safely used in 250°F water, and Teflon appears completely satisfactory at 450°F. (auth)

18520 (AEC-tr-4556) 2. ON THE EDDY CURRENTS INVOLVED IN THE SPONTANEOUS CHANGE OF MAGNETIZATION. B. Vvedenskiĭ. Translated from *Ann. Physik*, 64: 609-20(1921). 10p.

Considerations are given for the development of an eddy current in iron cylinders in which the magnetization varies aperiodically. Comparison is given of the results of experiments for six wire diameters from 0.161 to 6.0 mm to theoretical values. The agreement between experiment and theory is found to fail only when the wire diameter is <0.1 mm. (B.O.G.)

18521 (AEC-tr-4596) SPECTRUM OF IONIZED URANIUM. N. G. Morozova and G. P. Startsev. Aug. 29, 1956. Translated from *Optika i Spektroskopiya*, 2: 282-4(1957). 3p.

In spectral investigations of U ions, briquets of a compressed mixture of U_3O_8 and copper powder were excited in a high voltage condenser spark. The spectral lines behaved similarly indicating that their excitation potentials are close to each other. The first ionization potential of U is lower than that of Cu, and the excitation potentials of U(I) and U(II) are lower than those of similar Cu ions. (J.R.D.)

18522 (CEA-tr-R-533) DEUX POINTS DE CURIE DANS LES ALLIAGES Fe-Al. (Two Curie Points in Al-Fe Alloys). Sh. I. Zusman. Translated into French by B. De Trezvisky from *Fiz. Metal. i Metalloved.*, 9: 635-7(1960). 5p. (includes original, 1p.).

It is reported that for Fe alloys containing 13 to 14% Al at 450 to 550°C H_c increases sharply (tens or hundreds of times). This phenomenon is said to complicate the magnetization process and cause a decline in magnetization in weak fields. Oscillograms of hysteresis loops at 15 and 100 oersteds are shown for a 12% Al alloy during slow cooling. There is an abnormal increase in H_c between 575 and 475°C for the weak field. This is not observed for the strong field. The presence of two curie points is disproved. (T.R.H.)

18523 (JPRS-9057) PLASTIC DEFORMATION OF METALS. Vol. I. THE PHYSICO-MECHANICAL FOUNDATIONS OF PLASTIC DEFORMATION. S. I. Gubkin. Translation of p.1-376, Vol. I, of "Plasticheskaya Deformatsiya Metallov." (A publication of the Publishing House of Literature on Metallurgy, Moscow, 1960). 426p.

A monograph is presented on the physico-mechanical foundations of plastic deformation. The contents are given in discussions on the stressed state, the deformed state, and the plastic state. The special feature of the monograph

is the complex exposition of the problems of plasticity, in which the fundamental aspects of all directions of advance in the science of plastic deformation are unified and the physico-chemical theory of plasticity is consolidated. (JPRS)

18524 (NP-tr-564) HANDBOOK ON MACHINE-BUILDING MATERIALS, VOL. 2 FERROUS METALS AND THEIR ALLOYS. Translated from p.446-90; 501-27; 571-614 of *SPRAVOCHNIK PO MASHINOSTROITEL'NYM MATERIALAM TSVETNYYE METALLY I IKH SPLAVY*. (A publication of Publishing House of Scientific and Technical Machine-Building Literature, Moscow, 1959). 210p.

Reviews are presented concerning the applications, fabrication, and properties of rare metals and their alloys, and powder metal materials. Separate abstracts have been prepared for chapters IX and XI. (B.O.G.)

18525 (NP-tr-564(p.1-127)) RARE METALS AND THEIR ALLOYS. A. N. Zelikman and I. P. Kislyakov. Translation.

A review is presented of selected properties, applications, metallurgical techniques, joining methods, and cleaning of beryllium, molybdenum, niobium, tantalum, tungsten, zirconium, and their alloys. Some oxidation and thermal properties are included for vanadium alloys. (B.O.G.)

18526 (NP-tr-564(p.128-210)) POWDER METAL MATERIALS. M. Yu. Bal'shin. Translation.

A review is presented of fabrication methods and properties of powder metal materials. The discussion is given according to the basic types of materials. (B.O.G.)

18527 (NP-tr-601) NATURE OF "VISCOUS" BREAK-DOWN. V. A. Pavlov and M. V. Yakutovich. Translated from *Doklady Akad. Nauk S.S.S.R.*, 77: No. 1, 49-51(1951). 4p.

A study was made of the effects of plastic strain on the kinetics of the development and formation of microscopic flaws in plexiglas. Observations were made during tension in a field of plastic strain unequally distributed over the specimen in an artificially produced neck and near round openings running through the specimen. It was found that: microscopic flaws can be formed in the region of elastic strain, and they close up on removal of the load; the flaws are formed under the action of normal tensile stresses; plastic strain increases the probability of flaw formation, even in anisotropic substances; and flaws are formed only on the specimen surface. (B.O.G.)

18528 (SCL-T-363) STUDIES ON THE DIAGRAM OF Hg-In AND Hg-Tl-In ALLOYS. Hisashi Ito, Eijiro Ogawa, and Tsutomu Yanagase. Translated by Noburu Hiraga from *Nippon Kinzoku Gakkaishi*, 15b: 382-4(1951). 6p.

The studies were undertaken to determine the constitution diagrams of Hg-In and Hg-Tl-In alloys and to find their eutectic points below -60°C. Thermal analysis techniques were used to obtain the following eutectic points: Hg-23% In, -37.5°C; Hg-50% In, 32.5°C; 73% Hg-10% Tl-17% In, -55.15°C; and 51% Hg-8% Tl-41% In, -41°C. (B.O.G.)

18529 (UCRL-trans-656(L)) STUDY OF THE PORTevin-LE CHATELIER PHENOMENON AT VARIOUS TEMPERATURES IN ALUMINUM-MAGNESIUM ALLOYS. J. Caisso. Translated from *Rev. met.*, 56: 237-46(1959). 26p.

The tensile specimens underwent homogenization treatments at 500°C for 3 hr, followed by air tempering, and were allowed to stand for ~24 hr prior to testing. The influences of deformation speed, temperature, and percentage

of impurities were studied. The results are given relative to these parameters. The influence of the testing apparatus on the manifestations of the phenomena is discussed. (B.O.G.)

18530 (UCRL-Trans-662(L)) MICROFILMING OF THE MARTENSITIC TRANSFORMATION. A. L. Belinkii and V. I. Shtannikov. Translated from Zavodskaya Lab., 21: 62-6(1955). 7p.

The martensitic transformation in stannous bronzes were microfilmed at high speed. Methods of diminishing the indefiniteness of the martensitic crystals' first appearance are described. The method which gave the best results in this aspect is one in which the photographing was started at the first appearance of the martensitic crystals in the visual field. Data on growth rates are included. (J.R.D.)

18531 X-RAY STUDY ON SOLID SOLUTIONS OF OXYGEN IN HAFNIUM. Tore Dagerhamn (Univ. of Stockholm). Acta Chem. Scand., 15: 214-15(1961). (In English)

The solubility of oxygen in the hexagonal close-packed modification of hafnium is investigated. The introduction of oxygen in solid solution increases the hafnium lattice parameters a and c over the entire range of solubility. The axial ratio c/a , however, is practically constant after a slight rise at low oxygen contents. The limit of solubility was found to be 20.6 at. % ($\text{HfO}_{0.26}$). Samples with higher oxygen contents contain dioxide as an additional phase. (N.W.R.)

18532 NOTE ON A PHASE TRANSITION IN VO_2 . Sven Westman (Univ. of Stockholm). Acta Chem. Scand., 15: 217(1961). (In English)

The powder diffractogram of vanadium dioxide crystals was found to change, rapidly and reversibly, at about 70°C, the most obvious feature being the disappearance of all reflections hkl with h odd. At 180°C the effect was even greater and the crystal structure was derived and found to be essentially of the rutile type. A small splitting, less than the a_1 - a_2 separation, of the 101 and 210 powder reflections indicates a slight residual deformation of the rutile-type cell. The structural data obtained at 180°C are: space group, $P4_2/mnm$ (No. 136); unit cell dimensions, $a = 4.530 \pm 0.009$ Å and $c = 2.869 \pm 0.006$ Å; cell content, 2VO_2 ; $2V$ in $2(a)$, 000 , $\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{2}$; $4O$ in $4(f)$, $xx0$ etc., $x = 0.305 \pm 0.003$; and reliability factor $R = 0.12$. The transition is accompanied by changes in the expansion coefficient, the electrical resistivity, and the magnetic susceptibility. (N.W.R.)

18533 THE CRYSTAL STRUCTURE OF Zr_2Al_3 . T. J. Renouf and C. A. Beevers (Edinburgh Univ.). Acta Cryst., 14: 469-72(May 10, 1961). (In English)

The crystal structure of Zr_2Al_3 was determined by Patterson and Fourier methods on a small single crystal. The crystal is orthorhombic with $a = 9.601$, $b = 13.906$, $c = 5.57$ Å. The space group is $Fdd2$, with eight formula weights per cell. The structure is described and illustrated with a drawing of the unit cell. The zirconium atoms each have a co-ordination group consisting of nine aluminium atoms and four other zirconium atoms. The aluminium atoms are of two kinds, but each kind possesses a co-ordination group consisting of six zirconium atoms and four aluminium atoms. (auth)

18534 THE SEPARATION OF SHORT RANGE ORDER AND SIZE EFFECT DIFFUSE SCATTERING. Bernard Borie (Oak Ridge National Lab., Tenn.). Acta Cryst., 14: 472-4(May 10, 1961). (In English)

Short range order diffuse scattering in binary substitutional solid solutions is often obscured by modulations associated with the fact that the two kinds of atoms are of

different sizes. A method is described for the separation of these two components of the diffuse scattering, and it is illustrated by its application to CuAu. It is suggested that a determination of the size effect coefficients along with the short range order parameters will provide a greater insight into the short range structure of an alloy. (auth)

18535 EXPERIMENTAL DETERMINATION OF X-RAY COMPTON SCATTERING FROM CARBON BLACKS AND OTHER NON-CRYSTALLINE MATERIALS. M. A. Short (Pennsylvania State Univ., University Park). Acta Cryst., 14: 486-8(May 10, 1961). (In English)

A method is described for the experimental determination of the fraction of Compton scattering present in the total x-ray scattering from non-crystalline materials. The Compton scattering from a carbon black is measured and found to be in good agreement with that predicted by theory. (auth)

18536 X-RAY ABSORPTION FACTORS FOR ELLIPSOIDAL CRYSTALS. D. R. Fitzwater (Ames Lab., Ames, Iowa). Acta Cryst., 14: 521-6(May 10, 1961). (In English)

The absorption factor integral for a general ellipsoidal crystal was transformed to spherical polar coordinates. The resulting exponential in the integral was expanded in a power series and the triple integration was carried out term by term. The process was stopped after the fifth order term but could be carried further. Four integrals could not be directly integrated and were evaluated by series expansions and integrations. The resulting series were tabulated as a function of one parameter. The termination of the absorption factor series with the fifth order term gives results for a sphere with <2% error for $\mu R = 1.0$. (auth)

18537 NEUTRON DIFFRACTION BY HELICAL SPIN STRUCTURES. W. C. Koehler (Oak Ridge National Lab., Tenn.). Acta Cryst., 14: 535-6(May 10, 1961). (In English)

The intensity formulae necessary for interpreting neutron diffraction data for helical type structures may be simply derived by the application of the general theory of x-ray diffraction in disordered lattices as given by Zachariasen. (N.W.R.)

18538 THE CRYSTAL STRUCTURE OF CeCu. Allen C. Larson and Don T. Cromer (Los Alamos Scientific Lab., N. Mex.). Acta Cryst., 14: 545-6(May 10, 1961). (In English)

The orthorhombic crystal CeCu was examined by a precession camera and $\text{Mo K}\alpha$ x rays because of the ease in which this crystal oxidizes. The observed and calculated structure factors, parameters from the least-square refinement, and the interatomic distances are all tabularly presented. The unit cell dimensions are $a = 7.30$, $b = 4.30$, and $c = 6.36$ Å (all ± 0.02 Å), and it is shown that the crystal has the FeB structure. Systematic absences are hko with $h = 2n + 1$ and $Ok1$ with $k + 1 = 2n + 1$. (N.W.R.)

18539 THE ELECTRICAL CONDUCTIVITY OF GELATIN FILM HUMIDIFIED WITH HEAVY WATER VAPOR. C. D. Niven (National Research Council of Canada). Can. J. Phys., 39: 657-61(May 1961). (NRC-6255)

Protons in gelatin films are replaced by deuterium nuclei, by exposure of dry films to heavy water vapor. The conductivity of the film decreases markedly. The results are interpreted in terms of conductivity of hydrophilic substances. (T.F.H.)

18540 COMPOSITION AND STRUCTURE OF A TITANIUM-CHROMIUM COMPOUND. R. B. Golubtsova (Baikov Inst. of Metallurgy, Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R., 137: 593-6(Mar. 21, 1961). (In Russian)

Titanium-chromium alloys containing 1 to 80 wt.% Cr were prepared by fusion in an arc furnace for 4 hours at 1200°C, and were annealed at 800°C for 100 hours. These alloys were subjected to anodic dissolution at a current density of 0.03 to 0.1 amps/cm² in an electrolytic solution containing 5 ml HCl (sp. gr. of 1.19), 3 g succinic acid and 1000 ml methyl alcohol. X-ray and chemical analyses on the insoluble residue left at the anode showed that the intermetallic compound TiCr₂ is present in these alloys. (TTT)

18541 INTERMETALLIC COMPOUNDS IN AN ALPHA SOLID SOLUTION OF TITANIUM AND ALUMINUM. N. V. Grum-Grzhimailo, I. I. Kornilov, E. N. Pylaeva, and M. A. Volkova (Baikov Inst. of Metallurgy, Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R., 137: 599-602 (Mar. 21, 1961). (In Russian)

Titanium-aluminum alloys containing 0 to 40 wt.% Al were prepared by vacuum sintering at 1000°C for 100 hrs, 800°C for 50 hrs and 600°C for 100 hrs. Samples were also prepared by fusion in an arc furnace with a non-consumable tungsten electrode. Measurements of the Hall constant were made on the cast and annealed samples in order to establish the nature of the existing phases. The existence of the intermetallic compounds Ti₃Al and Ti₂Al was established from the changes in the Hall constant as a function of alloy composition. These intermetallic compounds account for the increased heat strength and sharp decrease in plastic properties of titanium alloys containing more than 7 to 8 wt.% Al. (TTT)

18542 THE ELECTRICAL PROPERTIES OF THE HEXABORIDES OF THE ALKALINE EARTHS, THE RARE EARTHS AND THORIUM. Yu. B. Paderno and G. V. Samsonov (Inst. of Metallo-Ceramics and Special Alloys, Academy of Sciences, Ukr. SSR). Doklady Akad. Nauk S.S.S.R., 137: 646-7 (Mar. 21, 1961). (In Russian)

The specific electrical resistances, the Hall coefficients, the thermal electromotive forces, concentrations of current carriers and mobilities are listed for the hexaborides of Ca, Sr, Ba, the rare earths and thorium. The temperature coefficient of the electrical resistance is positive for the rare earths with the exception of SmB₆ which has a negative coefficient up to 300°C, from which point the resistance starts to increase again. (TTT)

18543 EQUILIBRIUM OF THE TRIPLE METALLIC SYSTEM Ni₃Nb-Ni₃Ti-Ni₃Ta. I. I. Kornilov and E. N. Pylaeva (Baikov Inst. of Metallurgy, Academy of Sciences, U.S.S.R.). Izvest. Akad. Nauk S.S.S.R., Otdel. Khim. Nauk, No. 2, 197-200 (1961). (In Russian)

A physico-chemical analysis of equilibrium in Ni₃Nb-Ni₃Ti-Ni₃Ta indicated continuous solid crystallization. The liquidus phase for the system was constructed. Microstructure and hardness analyses confirmed the data. (R.V.J.)

18544 EVALUATION OF BERYLLIDES. J. R. Lewis (General Electric Co., Schenectady, N. Y.). J. Metals, 13: 357-62 (May 1961).

The intermetallic compounds formed between beryllium and the transition metals are hard, toxic, low density materials with good-to-excellent oxidation resistance and attractive nuclear properties. An evaluation of the properties is presented. The beryllides are quite brittle at temperatures approaching 2000°F and several exist whose melting point lies above 3000°F, although none are known which melt above 3700°F. They retain their mechanical strength to rather high temperatures—Zr₂Be₁₇ has a rupture modulus of 24,000 psi at 2750°F. Because the protective oxide which forms upon exposure to air is BeO, the beryllides need protection against water vapor attack. Plastic slip deformation

is observed to a slight degree above 2500°F in the MoBe₁₂ type. ZrBe₁₁ is extruded using molybdenum cans and extrusion temperatures about 80% of the absolute melting point. Thermal shock resistance is equal to that of some ceramic materials and inferior to graphite and fused quartz. (N.W.R.)

18545 MAGNETISM OF A SMALL PARTICLE AS REVEALED BY AN ELECTRON BEAM. S. Yamaguchi (Inst. of Physical and Chemical Research, Tokyo). Nuovo cimento (10), 19: 1053-4 (Mar. 1, 1961). (In English)

An experiment is described for measuring the surface and interior magnetic induction of ferromagnetic particles of about 3000 Å grain size. An electron beam is diffracted from the particles in a magnetic field. Hard electrons (~200 kv) are affected by the interior field, while soft electrons (~50 kv) are diffracted by the surface field. A comparison of the effects of the hard and soft electrons gives the internal/surface induction ratio. Examples are given of Ni-NiO grains and a ground surface of austenitic stainless steel. (T.F.H.)

18546 TEMPERATURE DEPENDENCE OF THE WORK FUNCTION OF METALS (Mo, Ni). George Comsa, Adrian Gelberg, and Beatrice Iosifescu (Inst. of Atomic Physics, Bucharest). Phys. Rev., 122: 1091-1100 (May 15, 1961).

The temperature coefficient of the work function (TCWF) of polycrystalline Mo and Ni is measured in the temperature ranges 600 to 1100°K and 475 to 1025°K, respectively, using the electron beam method. Special precautions are taken to avoid systematic errors due to the effects of residual gases, stray magnetic fields, incorrect temperature measurements, cathode temperature variations, etc. During determinations made upon Ni surfaces, the terrestrial magnetic field is compensated. Random error sources are likewise reduced as much as possible. The main results obtained on surfaces outgassed for many thousands of hours at pressures of 1 to 3 × 10⁻⁸ torr are TCWF = (7.84 ± 0.07) × 10⁻⁵ ev/°K for Mo, and TCWF = (-3.12 ± 0.05) × 10⁻⁵ ev/°K for Ni above the Curie point, θ . At the Curie point of Ni a theoretically expected variation of the TCWF is observed: TCWF(T < θ) - TCWF(T > θ) = (-0.99 ± 0.17) × 10⁻⁵ ev/°K, but no jump of the work function (WF) is found at this point. Experiments show that the results are not significantly affected by residual gases. A relation between the TCWF measured on polycrystalline surfaces of Ni and the TCWF of the various facets of these surfaces is obtained. (auth)

18547 POINT-DEFECT MIGRATION AND BINDING IN METALS. A. Sosin (Atomics International, Canoga Park, Calif.). Phys. Rev., 122: 1112-16 (May 15, 1961).

The kinetics of decay of an excess defect concentration in metals is examined with special attention to the initial stages of decay. A particular case, that of excess vacancy migration to sinks in a slightly impure metal, is treated; computer plots of isothermal and constant-temperature-rate recovery studies are analyzed. Initial recovery is determined by the migration energy only; final recovery is determined by an energy that is generally less than the sum of the migration plus vacancy-impurity binding energy but more than the migration energy alone. Initial and final recovery is easily resolved into two annealing stages. The intermediate recovery range may actually give rise to a resistivity increase. (auth)

18548 EFFECT OF PRESSURE ON THE ABSORPTION EDGES OF SOME III-V, II-VI, AND I-VII COMPOUNDS. A. L. Edwards and H. G. Dricamer (Univ. of Illinois, Urbana). Phys. Rev., 122: 1149-57 (May 15, 1961).

The effect of pressure to 160 kilobars was measured on

the absorption edges of the III-V compounds AlSb, GaSb, InP, and InAs, the II-VI compounds CdS, CdSe, and CdTe, and the I-VII compounds CuCl, CuBr, and CuI. It was possible to discuss the band structure of the III-V compounds with reasonable assurance relative to known group IV and III-V structures. For the II-VI and I-VII compounds, ionic and other effects were important. A number of new phase transitions were noted at high pressure. For CuCl and CuBr the T-P curves of some of these transitions were established. (auth)

18549 PHASE STUDIES OF Ni-Be ALLOYS. N. I. Blok, N. F. Lashko, and O. A. Khromova. *Zavodskaya Lab.*, 27: 251-6(1961). (In Russian)

The phases of Ni-Be, Ni-Be-W, and Ni-Be-Mo were studied. Electrolysis was carried out at room temperature with a current density of 0.06 amp/cm² in an electrolyte containing ammonium citrate and ammonia. The distribution of beryllium between phases was determined. (R.V.J.)

18550 MAGNETIC PROPERTIES OF BERYLLIUM IN TEMPERATURE RANGE OF 300 TO 4.2°K. B. I. Verkin, I. M. Dmitrenko, and I. V. Svechkarov (Inst. of Physics and Tech. for Low Temperatures, Academy of Sciences, Ukrainian SSR). *Zhur. Eksptl'. i Teoret. Fiz.*, 40: 670-1(Feb. 1961). (In Russian)

Angular dependence of χ for beryllium (above 20°K) and indium is found to be described by a cosine law. The temperature dependence of principal values of χ for beryllium is characteristic for small groups of electrons. The sensitivity of χ indium to impurities is noted. (auth)

18551 SYNTHESIS OF NEODYMIUM ALUMINATES AND SILICATES. N. A. Torpov and T. P. Kiseleva (Leninograd Technological Inst.). *Zhur. Priklad. Khim.*, 34: 498-505(Mar. 1961). (In Russian)

Ceramic properties of neodymium aluminates and silicates (Nd₂O₃-Al₂O₃ and Nd₂O₃-SiO₂) were studied. The CaF₂ mineralizer proved the most effective in producing neodymium oxyorthosilicate and pyrosilicate at comparably low temperatures. Neodymium monoaluminates possess high heat resistance ($T_{\text{melt}} = 2070^\circ\text{C}$) and good ceramic properties; high density, elasticity, and microhardness (1430 kg/mm²). (R.V.J.)

18552 NEW DESCRIPTION OF THORIUM SPECTRA. Romuald Zalubas (National Bureau of Standards, Washington, D. C.). *National Bureau of Standards Monograph* 17. June 21, 1960. 106p.

Wavelengths and estimated intensities in electrodeless lamp and spark sources are presented for 15,121 lines of Th(I), Th(II), Th(III), and Th(IV) in the spectral range from 2000 to 11,550 Å. Previously published interferometric values are in this table rounded off to three decimal places. (auth)

Radiation Effects

18553 (AD-247366) STUDY OF EFFECT OF HIGH-INTENSITY PULSED NUCLEAR RADIATION ON ELECTRONIC PARTS AND MATERIALS (SCORRE). Quarterly Progress Report No. 1; July 1, 1960-September 30, 1960. (International Business Machines Corp. Military Products Div., Owego, N. Y.). Contract DA36-039-SC85395. 18p. (IBM-60-511-13).

Test procedures and specific experiments to be carried out in the radiation testing of memory core circuits in Godiva are described. (D.L.C.)

18554 (BSR-500) ELECTRONIC CIRCUIT RESEARCH AND DEVELOPMENT FOR NUCLEAR PROPELLED

VEHICLES. Second Interim Engineering Report, January 1, 1961 to April 1, 1961. (Bendix Corp. Bendix Systems Div., Ann Arbor, Mich.). Contract AF33(600)-42262. 129p. (BSC-24551-17)

Activities in a program are described to test electronic circuitry in the nuclear environment of the Ford Reactor. Whenever possible, the samples were subjected to the combined environmental conditions of high and low temperatures, vibration, and altitude in addition to radiation. Work on modification, instrumentation, and testing is reported on components of equipment listed as AN/ARN-32 Marker Beacon Receiver, AN/ARC-34 UHF Transceiver, AN/ARN-31 Radio Receiving Set, AN/ARN-21 TACAN, AN/APX-19 Air-To-Ground Identification Set, AN/ART/27 (XA-5) Radio Beacon, and AN/APX-27 Transponder Set. Other tests are reported on tunnel diodes and transistors. (J.R.D.)

18555 (DP-527) MECHANICAL PROPERTIES OF IR-RADIATED ZIRCONIUM, ZIRCALOY, AND ALUMINUM. A Summary of the Data in the Literature. Richard E. Schreiber—Richard E. Schreiber and Erminia U. Kauer, comps. (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Jan. 1961. Contract AT(07-2)-1. 108p.

Changes in the mechanical properties of zirconium, zirconium alloys, aluminum, and aluminum alloys that are caused by fast neutron irradiation are presented in graphic form. These data were abstracted from classified and unclassified reports published by USAEC, AECL, and AERE since 1948. The materials that are included in this report are zirconium, Zircaloy-2, Zircaloy-3, Zr-2.5 wt.% Sn, 1100 aluminum (2S), 2024 aluminum, 5052 aluminum (52S), 5057 aluminum (57S), 5154 aluminum (A54S), 6061 aluminum (61S), 6063 aluminum (63S), X2219 aluminum, and X8001 aluminum. The mechanical properties for which data are reported include hardness, yield strength, tensile strength, total elongation, reduction of area, elastic modulus, fatigue strength, notch sensitivity, creep, stress relaxation, impact strength, and transition temperature. (auth)

18556 (NAA-SR-131(Del.)) ON THE RELEASE OF STORED ENERGY IN IRRADIATED GRAPHITE. D. L. Hetrick (North American Aviation, Inc., Downey, Calif.). June 27, 1951. Decl. with deletions Mar. 3, 1960. 52p. Contract AT-11-1-GEN-8.

The build up of stored energy in graphite during reactor irradiation and the release of stored energy by thermal annealing are analyzed in terms of reaction rate theory. A semi-empirical description of stored energy annealing up to 700°C valid for exposures less than 500 Mwd/T is obtained in terms of three sixth-order processes having discrete activation energies. The dependence of the activation energies on radiation exposure is obtained assuming the rate constant independent of exposure. It is found that processes having higher activation energies become increasingly important as irradiation continues. The activation energy of each process increases with exposure. The results are consistent with observations that radiation damage in graphite is less readily annealed at higher exposures. (auth)

18557 (NAA-SR-Memo-6271) IRRADIATION OF PLUTONIUM FUELS; A SELECTED BIBLIOGRAPHY. M. Bloomfield (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Apr. 13, 1961. 14p.

A bibliography on data pertaining to the irradiation of plutonium and plutonium alloys, dispersions, and compounds is presented. The 187 references to reports and published literature also contain information on physical

properties, production, preparation, and reprocessing methods. The 5 sections of the bibliography are: bibliographies, plutonium metal, uranium-plutonium alloys, aluminum-plutonium alloys, and plutonium oxides and other compounds. (auth)

18558 STRUCTURAL CHANGES INDUCED IN SOLID DEXTRAN BY IRRADIATION WITH GAMMA RAYS. Kirsti A. Granath and Per-Olof Kinell (Univ. of Uppsala). Acta. Chem. Scand., 15: 141-53(1961). (In English)

Dextran samples with various molecular properties were irradiated in air and in vacuum by gamma rays. Degradation occurs as is evidenced from changes in molecular weight. The rate of degradation is faster in oxygen but less reproducible. The energy per broken bond is in vacuum the same for all samples (19 ev) and it does not change with increasing dosage up to 18 Mrad. Gel filtration experiments have shown that irradiation in oxygen gives a molecular weight distribution which contains a larger weight fraction of low molecular material. Electron spin resonance data show that very stable free radicals are formed. A hypothesis is put forward that primarily a radical ion is formed which then dissociates into a positive ion and an alkoxy radical. The change in branching during the degradation indicates that simultaneous bond scission and rearrangements of the molecules occur. An increase in branching is typical for molecules having an initially low degree of branching, while a high number of branches originally will lead to the formation of less branched molecules. This is explained as due to the spatial conditions along the chain. In all cases the polymolecularity of the samples increases during the degradation. (auth)

18559 ELECTRON MICROSCOPE STUDY OF RADIATION DAMAGE IN GRAPHITE. W. Bollmann (Battelle Memorial Inst., Geneva). J. Appl. Phys., 32: 869-76(May 1961).

Neutron-induced defects in the graphite lattice are studied by dark-field transmission electron microscopy. The annealing process is observed, and the appearance of the defects is interpreted on the basis of the kinematical theory of electron diffraction. A physical interpretation of the observations based on displacement spikes and their annealing is given. (auth)

18560 VACUUM-ULTRAVIOLET ABSORPTION STUDIES OF IRRADIATED SILICA AND QUARTZ. C. M. Nelson and R. A. Weeks (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 32: 883-6(May 1961).

The optical absorption properties of Co^{60} -irradiated fused silica and crystalline quartz are studied in the vacuum-ultraviolet region. The most prominent absorption band found in both materials has a maximum at 7.6 ev (1620Å). Optical and thermal bleaching experiments indicate that this band is not necessarily complementary to a band at 5.9 ev (2100Å), as has been assumed. Though the 7.6 ev band has approximately the same intensity in both materials for the same irradiation, the 5.9 ev band is >20 times more intense in fused silica. The 7.6 ev band is still present after the 5.9 ev band is thermally bleached. Additional absorption bands occur at 8.0 and 8.2 ev. Also, optical and thermal bleaching experiments suggest other absorption bands at 7.2, 7.4, 7.8, and 7.9 ev. Since these bands (particularly the 7.6, 8.0, and 8.2 ev bands) occur in high-purity silica and quartz, it is suggested that they are associated with defects in the quartz structure and are not caused by impurities. (auth)

18561 MODIFICATION OF THE CATALYTIC ACTIVITY AND THE TEXTURE OF SILICA GELS IRRADI-

ATED IN REACTORS. G. Dalmai, B. Imelik, and M. Séguin (Centre d'Etudes Nucleaires, Saclay, France). J. chim. phys., 58: 292-5(Mar. 1961). (In French)

The effect of reactor irradiation on the catalytic activity and texture was studied for two silica gels, xerogel P and aerogel F_a. The samples were exposed in the EL-2 Reactor to 3×10^{19} n/cm² thermal, 0.8×10^{19} n/cm² (0.4 ev to 1 Mev), 0.68×10^{17} n/cm² fast, and 1.2×10^{18} r. The decomposition of formic acid was the test reaction. A partial breakdown of the texture was observed in the irradiated gels. The analysis of the absorption isotherms of nitrogen showed that the fritting produced is similar to that produced by thermal treatment at about 700°C. The tests of catalytic activity confirm that the effect of reactor irradiation is close to that of heating the catalyst. (J.S.R.)

18562 RADIATION POLYMERIZATION OF METHYL METHACRYLATE. Otto F. Joklik. Nuclear Energy, 211-20(May 1961).

A pilot plant is described for producing methyl methacrylate polymer. The monomer is irradiated by a 5 kc Co^{60} source for prepolymerization, and placed in an oven for completion of the polymerization. Data are given for conversion of monomer to polymer (in wt.%) and for average molecular weights as functions of irradiation doses at -18 to +70°C. The efficiencies of γ irradiation in polymerization of various monomers are compared. (T.F.H.)

18563 EFFECT OF FISSION SPECTRUM NEUTRONS ON n-TYPE GERMANIUM. Daniel Binder (Hughes Aircraft Co., Culver City, Calif.). Phys. Rev., 122: 1147-8(May 15, 1961).

The electron removal rate for n-type germanium irradiated with fission spectrum neutrons is 8 ± 1 per neutron at room temperature. This value is compared with the results of monoenergetic neutron irradiations from 2 to 5 Mev. The fact that the removal rate is roughly constant is explained by the constancy of the energy dissipated in elastic collisions. (auth)

18564 EFFECT OF GAMMA RADIATION ON CERTAIN MAGNETIC PROPERTIES OF IRON AND ITS ALLOYS. I. Ya. Dekhtyar and A. M. Shalaev (Inst. of Metal Physics, Academy of Sciences, Ukrainian SSR). Ukrain. Fiz. Zhur., 5: 677-81(Sept.-Oct. 1960). (In Ukrainian)

A study was made of the effect of gamma radiation on the galvanomagnetic effect, the coercitive force and magnetization of electrolytic iron, Fe-Ni alloy (24.96 per cent Fe) and an Fe-Cr alloy (50 per cent Cr). An attempt was also made to determine the type of defects formed under the action of gamma radiation. The Fe-Ni alloy was studied in a state after quenching at 1000°C in water and in an ordered state (annealing after quenching at 450° in the course of 170 hours). It was found that gamma radiation of quenched samples of Fe-Ni alloy causes an increase in the coercitive force and a decrease in the galvanomagnetic effect. During thermal ordering the change in these properties is in the same direction as in gamma radiation. This fact and the satisfactory agreement of the rectilinear dependence of the change in the galvanomagnetic effect on the quartz flux indicates that the gamma radiation caused the ordering of this alloy. The change in the coercitive force is also associated with the formation of defects of a dislocative nature during gamma radiation. Gamma radiation of Fe-Ni alloy in an ordered state does not result in any measurable changes in the physical properties. During gamma radiation of pure iron, an increase was found in the coercitive force and the magnetization of the samples. Graded annealing showed that the recovery of the coercitive force and magnetization occurs within the 580 to 780° interval. So high a

temperature of recovery indicates that during gamma radiation, defects of a dislocative nature are formed, possibly dislocation loops. During gamma radiation of Fe-Cr alloy an increase was noted in the coercitive force and a diminution of the galvanomagnetic effect. Graded annealing showed that in the regions of 300 and 550° there is a decrease in the coercitive force in pre-irradiated samples. The 300° region is the beginning of a metastable decomposition of the solid solution; the 550° region is the beginning of σ -phase isolation. The phenomenon of coercitive force decrease may be accounted for by the fact that during preliminary gamma radiation defects are formed which facilitate the formation of a new phase and the separation of this phase from the matrix. An analysis of the data leads to the conclusion that gamma radiation gives rise to two kinds of defects in metals: Frenkel's point defects and dislocation loops. (auth)

18565 SYMPOSIUM ON RADIATION EFFECTS AND RADIATION DOSIMETRY. Presented at the Sixty-third Annual Meeting, American Society for Testing Materials, June 29, 1960. ASTM Special Technical Publication No. 286. Philadelphia, American Society for Testing Materials, 1960. 159p. \$4.75.

Some of the latest research on the effects of radiation on materials properties, as well as discussion of parameters to be considered in predicting and evaluating such effects, are presented. Also presented are newer techniques for radiation dosimetry. Twelve papers are included; 5 were previously abstracted in *NSA*, separate abstracts have been prepared for the remaining 7. (N.W.R.)

18566 DETERMINANT SAMPLE PARAMETERS IN RADIATION EFFECTS TESTING OF HIGH POLYMERS. E. G. Fritz (Convair, Fort Worth, Tex.). p.3-16 of "Symposium on Radiation Effects and Radiation Dosimetry." Philadelphia, American Society for Testing Materials, 1960.

The effects of molecular weight, molecular architecture, reaction mechanism, and sample thickness on the radiation-induced response of high-polymer materials are analyzed. A statistical evaluation of the main-chain degradation process shows that, up to high doses, the molecular weight of the degraded system is a function of the initial molecular weight. Radiation-induced changes in physical properties also exhibit a sensitive dependence on the initial molecular weight distribution in the important early stages of degradation. Different degradative characteristics can arise from variations in mer sequence, mer orientation, branching, and crystallization. In addition, these elements of molecular architecture affect the diffusion coefficient and thus the residence time of free radicals in the sample. Considerable induction periods may precede steady-state conditions as a result of diffusion processes and chemical mechanism effects. Thus, if measurements are made during the induction period, they may lead to incorrect conclusions about the sample's ultimate behavior under steady-state conditions. It is concluded that test results are of little comparative value unless the polymer systems are defined in terms of their determinant molecular parameters. Sample thickness, test environment, and testing time should be chosen carefully to avoid vitiation by diffusion and mechanism effects. (auth)

18567 IRRADIATION TESTING OF ENRICO FERMI PROTOTYPE FUEL PINS IN THE CP-5 REACTOR. M. A. Silliman, A. A. Shoudy, P. R. Huebotter, and W. G. Blessing (Atomic Power Development Associates Inc., Detroit). p.17-32 of "Symposium on Radiation Effects and Radiation Dosimetry." Philadelphia, American Society for Testing Materials, 1960.

Three Enrico Fermi prototype fuel pins were irradiated in CP-5 reactor to average burnups of 0.27, 0.58, and 0.85% of the total atoms fissioned in the U-10 wt.% Mo fuel alloy. Through correlation of diameter measurements, temperature, and post-irradiation metallographic analysis, it is concluded that the radiation stability of the alloy is heavily dependent on the metallurgical condition of the material. The γ phase, stable above 1060°F, resists radiation more effectively than the $\alpha + \delta$ phases, which are thermally stable at temperatures less than 1045°F. Data from the CP-5 program suggest a more severe burnup limitation than was previously concluded. The disparity is believed to be due to the influence of the fission-rate parameter on the microstructure of the material during irradiation. Fission events, if they occur with sufficient frequency, maintain the γ phase at temperatures below 1060°F. If the critical rate is not attained, the alloy will transform thermally in accordance with the U-Mo equilibrium diagram and the macroscopic temperature of the material. (auth)

18568 REACTOR SPECTRA CONSIDERATIONS IN RADIATION EFFECTS PREDICTIONS. J. Romanko (Convair, Fort Worth, Tex.). p.58-67 of "Symposium on Radiation Effects and Radiation Dosimetry." Philadelphia, American Society for Testing Materials, 1960.

A brief discussion is given on the specification of reactor differential flux spectra for both neutrons and gamma rays, specifically on the differential flux spectra of a typical light-water-moderated reactor, the Ground Test Reactor. Following this, calculations of displacement production rates in crystalline solids such as metals and semiconductors for various specifications of the neutron flux spectrum are given. Examples are chosen to illustrate the relative importance of the various energy groups of neutrons. The extent of the errors introduced in the calculations, when incorrect specifications of flux spectra are used, is indicated. The importance of specifying differential gamma flux spectra in radiation damage studies concerning organics is stressed briefly. (auth)

18569 EFFECT OF SAMPLE PARAMETERS ON ENERGY ABSORPTION FROM A NEUTRON BEAM. R. L. Johnston (Convair, Fort Worth, Tex.). p.76-81 of "Symposium on Radiation Effects and Radiation Dosimetry." Philadelphia, American Society for Testing Materials, 1960.

A Monte Carlo Computer Program was used to investigate the effects of sample size, shape, and composition on the amount of energy lost from a monoenergetic neutron, beam incident upon one face of the sample. Cylinders, spheres, and rectangular parallelepipeds are considered. The composition calculations confirm that the energy absorbed by compound samples can be calculated, using a simple additivity assumption, from data obtained for pure element samples provided the pure element and compound samples are the same size and shape. The effect of sample shape was investigated by calculating the energy lost by monoenergetic neutrons in penetrating cylinders of identical mass but widely varying thickness and radius. It is apparent from these data that neglect of sample shape can lead to serious errors in the calculation of energy absorption values. (auth)

18570 IMPROVEMENTS RELATING TO THE MANUFACTURE OF PLASTICS. Arthur Charlesby and Solomon Harris Pinner (to T. I. (Group Services), Ltd.). British Patent 866,069. Apr. 26, 1961.

A method is described for inducing polymerization of monomers within the body or on the surface of a polymeric material, by electron, γ , or x irradiation. The treatment

can be applied to prefabricated articles, so that the shape is retained; the thermal and chemical resistance and mechanical properties of the polymers are improved by the treatment. Stable mixtures of polymers may be produced by this method that cannot be readily made in any other way. (T.F.H.)

18571 IMPROVEMENTS RELATING TO THE MANUFACTURE OF PLASTICS. Arthur Charlesby and Solomon Harris Pinner (to T. I. Group Services Ltd.). British Patent 867,646. May 10, 1961.

A process for subjecting a monomer to the action of ionizing radiation at an intensity greater than 0.1 Mr per minute to cause it to be polymerized when the monomer is

in contact with a solid polymer is described. The polymer may be in powdered form or in the form of a sheet. The monomer is in the liquid form and a nonpolymerizable liquid is added to the monomer to facilitate dissolution or swelling of the polymer. The desired dose is delivered by gradually treating the swollen polymer in the monomer with a portion of the total desired dose. Then the polymer is re-swollen in the monomer and treated with a further dose until the desired dose is reached. The polymers are polyethylene or cellulose. The monomers are methyl methacrylate, methacrylic acid, vinyl acetate, acrylonitrile, or vinylidene chloride. The ionizing radiation is a beam of electrons from a Van de Graff generator. (N.W.R.)

PHYSICS

General and Miscellaneous

18572 (ARF-4132-12) PROPAGATION OF PRESSURE WAVES IN A MIXTURE OF WATER AND STEAM. H. B. Karplus (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Jan. 1961. Contract AT(11-1)-528. 89p.

The velocity of sound in mixtures of water and steam was computed from the slope of the lines of equal entropy over a wide range of ambient conditions up to the critical point. The sound velocity is lower in the mixture than in either constituent. It changes discontinuously on transition to the single phase in wet steam with just a trace of liquid. The velocity is about 10% less than in dry steam. The velocity decreases monotonically with increasing water content. In boiling water the velocity is very low. The smallest value occurs at reduced pressure at the triple point (with no solid ice present); the velocity here is as low as 0.012 m/s. Rankine-Hugoniot curves were calculated for the mixture. These show that a shock-like compression in very wet steam or boiling water will condense all the steam, giving rise to a large change in volume with very little rise in pressure. The Hugoniot curve lies very close to a line of constant entropy in this case. For high quality steam the compression will raise the temperature of the vapor and evaporate the liquid phase. This occurs far from constant entropy conditions, indicating a strong loss mechanism. In boiling water the propagation was studied with pressure waves having an amplitude exceeding the minimum necessary to condense all the steam. The velocity decreases monotonically with decreasing driving pressure, approaching the small amplitude acoustic velocity when the driving pressure approaches the minimum necessary to condense all the steam. In a straight pipe of boiling water true shocks were not propagated. The rise time of the compression wave steadily increases as it passes through the medium. On finally reaching a region of no bubbles, high peak pressures are observed. These peaks were an order of magnitude greater than the original driving pressure. This amplitude is apparently due to the formation of a water hammer. (auth)

18573 (CEA-1836) MESURE, PAR EFFET MOSSBAUER, DE CHAMPS LOCAUX DANS DIVERS COMPOSES DU FER. (The Measurement of Localised Fields in Different Iron Compounds by Means of the Mossbauer Effect). Ionel Solomon (France. Commissariat à l'Énergie Atomique. Centre d'Etudes Nucléaires, Saclay). 1961. 3p.

The Mossbauer effect was observed in substances: which have a zero local field; which have an instantaneous local field value which is not zero but which, as a result of rapid fluctuations, has a field which averages zero; and such as garnets for which the values of the local field were measured for the two sites. (auth)

18574 (IS-191) ANNUAL SUMMARY RESEARCH REPORT IN PHYSICS, JULY 1, 1959—JUNE 30, 1960. (Ames Lab., Ames, Iowa). Sept. 1960. Contract W-7405-eng-82. 71p.

Research in theoretical and experimental physics is summarized. The method of Wyse and Mayall for estimation of density distributions in stellar galaxies from observed rotational velocities was extended to a more realistic model. Methods of calculating pair production or bremsstrahlung cross sections are discussed. The presence of 10 previously unreported γ rays was observed in the decay

of Ag^{113} . The photoproton yield from Be^9 was investigated. Theoretical studies were made of a proposed new type of electron multiplying discharge. The Seebeck coefficients of several single crystals of Mg_2Si were measured from 7 to 1000°K. New data were obtained on the resistivities and Hall coefficients of Mg_2Si . A new technique for measuring the thermal diffusivities of solids was devised. A dynamic pulse-heating method was developed for measuring the specific heats of metal wires from room temperature to 1000°C. The specific heat of copper was determined. Methods for measuring microwave Hall mobilities in semiconductors were improved. The resistivity of sodium tungsten bronze as a function of sodium composition was obtained down to 4°K. Studies are being made of the frequency dependence of the resistance and capacitance of samples of AgBi . A single crystal of holmium metal was obtained by annealing an arc-melted button and examining in fields up to 18 kilogauss. Magnetic moments in erbium crystals were investigated. The resistivities of nearly all of the rare-earth metals in polycrystalline form were determined down to 1.3°K. Highly degassed samples of high-purity tantalum were produced. The superconducting properties of a solid phase of mercury were investigated. The effect of pressure on the superconducting critical field curve of tin was also measured. The effect of pressure on the Curie temperature of dysprosium was measured. A study was made of the absorption and dispersion mode nuclear magnetic resonance signals of Li^7 in solid lithium metal. Nuclear quadrupole resonances in very ionic halides were measured. The crystal counting properties of diamond were used to study the processes associated with charge carrier trapping. The sublimation of indium from alloys with silver was investigated. (M.C.G.)

18575 (JPLAI-LS-294) THERMIONICS AND THERMOELECTRICITY. ASTRONAUTICS INFORMATION LITERATURE SEARCH NO. 294. Edda Barber, comp. (California Inst. of Tech., Pasadena. Jet Propulsion Lab.). Dec. 1960. Contract NASw-6. 185p.

An annotated bibliography is presented, consisting of 1006 references to publications on thermionics and thermoelectricity. The following sources were consulted: JPL Book File and Subject Index; Books in Print 1960; JPLAI-Abstracts through Nov. 1960; JPLAI-Survey through Nov. 1960; ASTIA through Sept. 1960; Nuclear Science Abstracts, Jan. 1950—Oct. 31 1960; Physics Abstracts, Jan. 1950—Aug. 1960; Electrical Engineering Abstracts, 1953-59; Semiconductor Electronics, 1957-59; Engineering Index, 1950-59; and Applied Science and Technology Index, Jan. 1958—Sept. 1960. Author and subject indices are included. (B.O.G.)

18576 (MLM-1110) MOUND LABORATORY PROGRESS REPORT FOR JANUARY 1961. J. F. Eichelberger (Mound Lab., Miamisburg, Ohio). Jan. 31, 1961. Contract AT-33-3-GEN-53. 22p.

Work was begun to determine the physical properties of mica-filled diallyl phthalate. Both the impact and tensile strength values compared favorably with asbestos-filled DAP formulations. The tensile values compared with the upper limit tensile strength values for asbestos-filled formulations. Adiprene-ferric acetyl acetate-polyol systems were developed as adhesives and their properties studied. Sources of kilogram quantities of Th^{230} were investigated. The samples were analyzed by a direct CeF_3

precipitation procedure or by a tributyl phosphate-cerium procedure. The half-life of Ra^{223} was found to be 11.3700 ± 0.0065 days. Differential thermal analyses were made of lanthanum and praseodymium metals. Three preliminary determinations of the density of molten cerium were made by the vacuum pycnometer method. An average value of 6.58 was obtained. Leaching tests in water and in 0.1N HCl were continued on fibers of an experimental glass containing 10 wt.% plutonium oxide. (M.C.G.)

18577 (MND-P-2398(Add.1)) Snap III. FINAL PERFORMANCE TEST SUMMARY. (Martin Co. Nuclear Div., Baltimore). Mar. 1961. Contract AT(30-3)-217. 13p.

This report includes data obtained during the final six months of a life test program on the SNAP 3, 3M-1G10 generator and supplements information previously discussed in Section E of the Final Performance Test Summary. The life test was initiated on January 26, 1960, and 322 days of continuous operation at steady-state power input conditions were completed on December 13, 1960. The thermal power input to the generator was terminated on December 19, 1960, after the generator had been operated under a full range of external loads for determining post-life-test performance characteristics. The electrical power output after 322 days at steady-state heat source conditions and external load conditions was 1.92 watts, corresponding to an over-all efficiency of 2.9%. Teardown inspection of the generator confirmed previous indications of increased internal electrical resistance and increased thermal conductivity. These conditions resulted from lead telluride sublimation at thermoelectric hot junction temperatures of 950 to 1000°F and occurred primarily during the first 60 days of operation, when 54% of the total performance reduction took place. These observations account for the gradual reduction in generator performance from its start-of-life electrical output of 3.45 watts and over-all efficiency of 5.2%. (auth)

18578 (OOR-1995.3) PRECISION MEASUREMENTS ON CERTAIN FUNDAMENTAL NATURAL CONSTANTS OF PHYSICS AND CHEMISTRY. (California Inst. of Tech., Pasadena). Mar. 22, 1961. Contract DA-04-495-ORD-1117. 11p.

Efforts on the redetermination, with improved accuracy, of certain constants and conversion factors in physics and chemistry are summarized. These include the conversion constant $\Lambda = \lambda g / \lambda s$ for converting wavelengths from the Siegbahn nominal scale of x-ray wavelengths in "x-units" to the cgs scale in milliangstrom units, the voltage wavelength conversion factor $hc^2(e\Lambda)$ expresses in x-units, and the Faraday constant. The method chosen for attack on this problem was that of photographing on the same spectrographic plate the x-ray spectral lines whose wavelengths are to be determined and the Lyman-series lines from hydrogen-like atoms which were stripped of their electrons in high-voltage sparks. The instrument used for this project was a vacuum spectrograph of the Rowland type, with ruled, concave grating and with the slit mounted so as to give a very small angle of grazing incidence on the grating. Theoretical studies were carried out to determine the types of ruled gratings best suited for use in this spectral region. (M.C.G.)

18579 (OOR-2810.2) PHOTON ABSORPTION BY VALENCE ELECTRONS IN NICKEL AND COPPER. Technical Report No. 2. D. H. Tomboulion (Cornell Univ., Ithaca, N. Y.). Apr. 1961. 15p.

An investigation was made of photon absorption by valence electrons in copper and nickel. The dispersing instrument was a normal incidence vacuum spectrograph which was

adjusted to operate in the spectral region extending from 200 to 900Å. The source of radiation was a condensed spark discharge in argon. Intensity comparisons were made by the use of a special photographic emulsion. In nickel, the peak position of the K and $M_{2,3}$ spectra did not coincide. However three of the valence band peaks indicated a good correlation with the K-edge fine structure and were S→p transitions. In copper, the M emission band showed a peaking of the intensity near the emission edge. Two peaks at 23.3 and 35.0 eV appeared to have their counterpart in the K spectrum. There seemed to be little correlation with $M_{2,3}$ edge data, indicating that states having p character are missing. The results are compared with Hayasis' theory. (M.C.G.)

18580 (ORNL-3085) PHYSICS DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING FEBRUARY 10, 1961. (Oak Ridge National Lab., Tenn.). May 3, 1961. Contract W-7405-eng-26. 114p.

Results are discussed for investigations of: elastic scattering of bound nuclei; center-of-mass energy in Overhauser's self-consistent field with giant density fluctuations; the distorted-wave theory of direct nuclear reactions; an excitation method for an optical maser; energy spectra for β decay of He^6 ; electron shake-off following He^6 decay; neutrons from He^3 bombardment of Be^9 , C^{13} , and Li^7 ; total neutron cross section of Pb^{208} ; neutron total cross sections for selenium isotopes at 4 to 50 keV; statistical parameters of nuclei from kev neutron total and capture cross sections; high-resolution total neutron cross sections of Am^{241} and Np^{237} ; Breit-Wigner resonances; neutron radiative capture at 200 to 6000 eV; gamma spectra from 30-kev neutron capture; γ - γ angular correlations in Xe^{132} ; Coulomb excitation of levels in Se^{77} ; Mössbauer method of HFS splitting of Au^{197} alloys with iron, cobalt, and nickel; magnetic ordering in rare-earth intermetallic compounds; frequency calibrations of prism spectrometers and spectral slit-width measurements; vapor-phase infrared absorption spectra of HfF_4 , TiF_4 , and ZrF_4 ; polarized deuteron sources; pulse characteristics of fast phototubes; properties of semiconductor detectors; and the response of silicon detectors to fission fragments. (B.O.G.)

18581 (TID-12633) HYDROGEN TRANSPORT PROPERTY CORRELATIONS. J. D. Rogers, K. Zeigler, and P. McWilliams (Los Alamos Scientific Lab., N. Mex.). [1961]. 17p.

Hydrogen transport property correlations in the form of equations readily adaptable to machine computations were developed for both thermal conductivity and viscosity of normal gaseous hydrogen, para hydrogen, dense phase hydrogen, and dissociating hydrogen. The forms of the correlating equations developed were determined primarily for their ability to represent the data. To include the effect of pressure, empirical formulas were developed in the form of the residual transport property as a function of density. (M.C.G.)

18582 (AFCL-56) HETERODYNING OF LIGHT. S. I. Borovitskii and G. S. Gorelik. Translated from Uspekhi Fiz. Nauk, 59: 543-52(1956). 13p.

The heterodyning or mixing of two incoherent light emissions is discussed. The nonlinear link required for heterodyning is a photoelectric converter. The conversion of an optical doublet into radiofrequency oscillations can be performed by heterodyning light. The shot effect, or the photon mechanism of electron emission, is described. Heterodyning of light was also treated as the demodulation of modulated oscillations or the appearance of random modulation of light whose spectrum is an unsplit spectral line. Previous experiments are reviewed. (M.C.G.)

18583 (CEA-tr-A-877) SOLUTIONS À SYMÉTRIE AXIALE DE L'ÉQUATION MAGNÉTO-HYDROSTATIQUE AVEC COURANTS SUPERFICIELS. II. (Solutions with Axial Symmetry of the Magneto-Hydrostatic Equation with Surface Currents. II). K. Jörgens. Translated from *Z. Naturforsch.*, 13a: 493-8(1958). 20p.

The representations for any section of a plasma with surface currents and thus for the azimuthal components which do not disappear are obtained. A method is then given for the determination of the singularities of the exterior field, and by this means the region where the solution exists. The method is applied to the circular and elliptical sections. For the toric circle, the solution is regular throughout the whole region if the azimuthal component of the field is not smaller at the interior than at the exterior. (J.S.R.)

18584 SMALL MHD POWER GENERATOR USING COMBUSTION GASES AS AN ENERGY SOURCE. G. J. Mullaney and N. R. Dibelius (General Electric Co., Schenectady, N. Y.). *ARS (Am. Rocket Soc.) J.*, 31: 555-7(Apr. 1961).

A small MHD channel was used to investigate the fundamental principles of this method of power generation. In the experiments described, the potassium concentration was varied from 1 to 6% by weight of the combustible mixture. The power output of the generator increased as the square root of the potassium concentration, following the trend established in conductivity experiments made earlier. The output power was 55% of the calculated value. Power extraction was transverse to both magnetic field and gas flow, and continuous electrodes were employed. (auth)

18585 SIMILAR SOLUTIONS OF THE FREE CONVECTION BOUNDARY LAYER EQUATIONS FOR AN ELECTRICALLY CONDUCTING FLUID. Barry L. Reeves (Calif. Inst. of Tech., Pasadena). *ARS (Am. Rocket Soc.) J.*, 31: 557-8(Apr. 1961).

A solution of the problem of the free convection boundary layer adjacent to a vertical plate with a uniform surface temperature is presented. The surrounding medium is an electrically conducting fluid and an applied magnetic field is normal to the direction of fluid motion. It is shown that a class of similar solutions exists for an electrically conducting fluid in the case of constant wall temperature. (N.W.R.)

18586 GROWTH OF MAGNETOHYDRODYNAMIC BOUNDARY LAYER. J. C. Wu (Douglas Aircraft Co., Inc., Santa Monica, Calif.). *ARS (Am. Rocket Soc.) J.*, 31: 562-4(Apr. 1961).

In the presence of uniform transverse magnetic fields, laminar boundary layers grow in an approximately exponential fashion rather than parabolically as would exist in similarity cases. A rigorous analysis is given in support of this fact and the numerical results are obtained through the use of a finite difference technique. It is further demonstrated that for cases where the magnetic interaction parameter mx exceeds unity, the growth of the boundary layer becomes very rapid. The possible re-entry applications of this rapid boundary layer are discussed. The differences between electromagnetic forces and adverse pressure forces are also discussed briefly. (N.W.R.)

18587 ON ENERGY PROBLEMS OF INTERSTELLAR SPACE FLIGHT. G. Marx (Roland-Eotvos Univ., Budapest). *Astronaut. Acta*, 6: 366-72(1960). (In German)

The principal energy conditions of interstellar space flight are discussed from the viewpoint of physics. The law of conservation for baryonic charge prevents the realization of relativistic rocket programs by means of chemical

or nuclear propulsion. Antimatter seems to offer the only possibility of reaching other stellar systems within a human lifetime. (auth)

18588 ELECTRODYNAMIC QUANTIZATION PROCEDURE. C. L. Hammer and R. H. Good, Jr. (Ames Lab., Ames, Iowa). *Ann. Phys.*, (N. Y.), 12: 463-75(1960). (IS-81)

Recently a quantum theory of the free Maxwell field was given that avoided discussion of nonphysical photons. An extension of this theory to include interactions with electrons is given. This approach leads to a formulation equivalent to the gauge-independent theory of Belinfante and Lomont. A discussion of the integrals of motion is given, including their connections with displacement operators. (auth)

18589 REPRESENTATIONS OF THE UNITARY GROUP AND WAVE FUNCTIONS. H. A. Venables (Univ. of Alberta, Edmonton). *Can. J. Phys.*, 39: 510-13(Apr. 1961).

A number of wave functions other than spherical harmonics are obtainable from the irreducible representations of the two-dimensional unitary group. (auth)

18590 EQUIVALENT PRESSURE CONCEPT IN CROSSED ELECTRIC AND MAGNETIC FIELD IN ELECTRODELESS DISCHARGE. S. N. Sen and A. K. Ghosh (Jadavpur Univ., Calcutta). *Indian J. Phys.*, 35: 101-4 (Feb. 1961). (In English)

The breakdown potential in air in crossed electric and magnetic fields within the pressure range 10^{-3} to 1 mm of Hg was measured. The discharge was excited by a 10 kv transformer. The magnetic field was varied from 50 to 2000 gauss, and three discharge tubes of 9, 22.5, and 26.5 cm were used. From the measured breakdown potential data, the values of P_e/P were calculated using both Wehrli's formula, and Blevin and Haydon's formula, where the magnetic field is taken as 100 gauss. From the curves obtained it can be concluded that both expressions for P_e are of limited applicability and the concept of equivalent pressure alone cannot explain all the observed results. It is hoped that the incorporation of variation of γ with H along with equivalent pressure concept will explain the observed changes better. An expression of E/P is developed for this purpose. (N.W.R.)

18591 END EFFECT LOSSES IN dc MAGNETOHYDRODYNAMIC GENERATORS. Roland A. Boucher and Dennis B. Ames (Hughes Aircraft Co., Culver City, Calif.). *J. Appl. Phys.*, 32: 755-9(May 1961).

End effect loss in a d-c magnetohydrodynamic generator with rectangular cross section is considered. The case for nonconducting walls is examined, and a simple expression for the losses in terms of the maximum power output is obtained. The end effect loss is compared to viscous and turbulent flow losses; end effect is shown to be the predominant cause of loss over a wide range of operating conditions. (auth)

18592 OSCILLATIONS AND SATURATION CURRENT MEASUREMENTS IN THERMIONIC CONVERSION CELLS. R. J. Zollweg and Milton Gottlieb (Westinghouse Research Labs., Pittsburgh). *J. Appl. Phys.*, 32: 890-4(May 1961).

Radio-frequency oscillations observed in cesium-filled thermionic diodes are interpreted on the basis of a model that assumes that the cesium ions oscillate in an excess negative charge potential well outside the cathode. A simplified theoretical treatment shows that the period at the onset of oscillations is linear with cathode-anode spacing, in agreement with experiment; the theoretical treatment relates the oscillation period to the cell current-saturation emission current ratio. It is found that the rapid decrease

of oscillation amplitude as the cell current reaches a critical value can be used to measure saturation emission currents. (auth)

18593 PROPAGATION OF WAVES IN A PLASMA IN A MAGNETIC FIELD. William P. Allis (Massachusetts Inst. of Tech., Cambridge). IRE Trans. on Microwave Theory and Tech., MTT-9: No. 1, 79-82 (Jan. 1961).

The propagation of electromagnetic waves in a plasma in a magnetic field as given by the Appleton-Hartree theory is discussed in terms of the wave normal surfaces instead of the more conventional propagation vector plots, and the "ordinary" and "extraordinary" waves are defined in terms of their polarizations instead of using a continuity argument. This gives a different picture of "a wave" which has some advantages. In particular, "whistlers" become obvious, as are regions of high reflection and high absorption. The Appleton-Hartree theory is then extended to include the effect of electron temperature, and this results in a third wave whose velocity is of the order of electron thermal motions. (auth)

18594 THE EXTENSION OF A LAGRANGIAN FORMULA TO EIGENVALUE PROBLEMS. Jacques des Cloizeaux (Centre d'Etudes Nucléaires, Saclay, France). Nuclear Phys., 20: 321-46 (1960). (CEA-1867). (In French)

An implicit eigenvalue equation may be transformed into an ordinary eigenvalue problem by generalizing the Lagrange formula to operators. A method is given to build a constant operator h which has the same eigenvalues and eigenvectors as the original equation. Moreover it is possible to find a hermitian operator K which has the same eigenvalues and whose eigenvectors are related in a simple way to the original ones. The method is applied to the calculation of perturbation expansions for bound states starting from the Brillouin-Wigner formula. In this case, the eigenvectors of K have a simple geometric meaning and may be considered as unperturbed wave functions. (auth)

18595 ON CYLINDRICAL MAGNETOHYDRODYNAMIC SHOCK WAVES. Carl Greifinger (RAND Corp., Santa Monica, Calif.) and Julian D. Cole. Phys. Fluids, 4: 527-34 (May 1961).

If an axial rod is surrounded by an ionized gas, an expanding cylindrical shock wave can be produced by passing through the gas a current which returns along the rod. The azimuthal magnetic field of the current acts like a piston, pushing the plasma away from the rod and leaving behind a cylindrical vacuum region. The case is considered in which a uniform axial magnetic field is initially present in the gas; in this case a transverse magnetohydrodynamic shock wave results from the current discharge. The flow is analyzed under the assumptions that the plasma is a non-viscous, nonheat-conducting, ideal gas of infinite electrical conductivity, and that the discharge current increases linearly with time. The analysis is made first on the basis of the "snowplow" theory of Rosenbluth, and then from a similarity solution of the full magnetohydrodynamic equations. The results of the two solutions are compared for the case $\gamma = 1/2$. It is found that the speed predicted by the snowplow theory is in very good agreement with the speed of the contact front obtained from the solution of the full equations over the entire range of shock strength, but that the snowplow speed is a good approximation to the shock speed only in the limit of strong shocks. The effect on the flow of varying the axial field is discussed. (auth)

18596 VISCOSITY OF DISSOCIATED GASES FROM SHOCK-TUBE HEAT-TRANSFER MEASUREMENTS.

R. A. Hartunian and P. V. Marrone (Cornell Aeronautical Lab., Inc., Buffalo). Phys. Fluids, 4: 535-43 (May 1961).

Measurements of the heat transfer from dissociated oxygen to the sidewall of a shock tube are made over a wide range of operating conditions using the methods of thin-film thermometry. Numerical solutions of the equilibrium shock tube wall boundary layer equations for several values of the Lewis number are obtained. The results show the heat transfer to be very weakly dependent upon the Lewis number. This fact indicates the shock-tube wall boundary layer to be a source for experimental determinations of the viscosity coefficient of dissociated gases. Experimental data obtained in the equilibrium boundary layer regime agree with the theory at the low temperatures, and rise above the theoretical curves at the higher temperatures. This difference between theory and experiment is attributed to the uncertainty in the calculated viscosity coefficient used in the theory. The experiments are then used to determine new values for the viscosity coefficient of high temperature, dissociated oxygen. (auth)

18597 VISCOUS MAGNETOHYDRODYNAMIC BOUNDARY LAYER. A. Sherman (General Electric Co., Cincinnati). Phys. Fluids, 4: 552-7 (May 1961).

The behavior of the Blasius boundary layer, for a fluid of constant electrical conductivity, in the presence of a non-uniform magnetic field is studied. Distortion of the applied field due to currents flowing in the fluid is neglected; that is, the magnetic Reynolds number is assumed to be zero. Since the fluid is of uniform conductivity, the influence of the pressure distribution, caused by the interaction between the magnetic field and the inviscid flow, on the boundary layer is taken into account along with the Lorentz body force within the layer itself. The nonlinear boundary layer equations are solved by the method of power series expansion utilizing the Görtler variables. Particular attention is given to the case in which the nonuniform field is established in a constant height channel. The boundary layer, then, is assumed to begin at some position along one wall, and grow in the downstream direction. For purposes of computation, the problem is further specialized to treat the case in which the nonuniform field is generated by a current-carrying wire imbedded in one wall of the channel and aligned normal to the flow. The results of a calculation, for one choice of the relevant nondimensional parameters, show that the reduction in skin friction is sufficient to separate the boundary layer. (auth)

18598 CLASSICAL CLUSTER INTEGRAL THEORY OF FLUIDS IN EXTERNAL FIELDS. Russell V. Hanks (Boeing Scientific Research Labs., Seattle). Phys. Fluids, 4: 580-6 (May 1961).

Cluster integral expansions of the classical grand ensemble partition function, and singlet and pair distribution functions of fluids in external fields are discussed. Certain topological properties of terms occurring in the pair distribution function are examined and used to derive an exact integral equation for a subset of these terms. Approximations that form the activity-dependent analogs of the "chain" and "series-parallel" approximations are obtained from this equation and discussed. The thermodynamic properties of a classical single-component electron gas in a homogeneous electric field are also calculated. (auth)

18599 EXPERIMENTS IN STEADY STATE CROSSED-FIELD ACCELERATION OF PLASMA. George P. Wood, Arlen F. Carter, Alexander P. Sabol, and Richard H. Weinstein (Langley Research Center, Langley Field, Va.). Phys. Fluids, 4: 652-3 (May 1961).

Experiments are described in which steady state acceleration of N plasmas seeded with Cs is achieved at current densities of 6 to 30 amp/cm². The plasmas, initially near Mach 2, are accelerated by linear d-c crossed electric and magnetic fields. (T.F.H.)

18600 THEORY OF NEGATIVE IONS IN LIQUID HELIUM. C. G. Kuper (Univ. of Illinois, Urbana). *Phys. Rev.*, 122: 1007-11 (May 15, 1961).

It is shown that an electrostriction model gives reasonable values for the mobility of positive ions in liquid helium. However, that model cannot account for the observed difference between positive- and negative-ion mobilities. Arguments are advanced in support of the "bubble" model; the negative ion is believed to be a free electron in a cavity of radius about 12 Å. The bubble model leads to a mobility in fair agreement with experiment. (auth)

18601 EFFECT OF PLASTIC DEFORMATION ON THE LOW-TEMPERATURE IONIC CONDUCTIVITY OF POTASSIUM CHLORIDE. B. S. H. Royce and R. Smoluchowski (Princeton Univ., N. J.). *Phys. Rev.*, 122: 1125-8 (May 15, 1961).

Measurements are made on the ionic conductivity of KCl between 25 and 250°C. Both undeformed crystals and specimens having up to 24% plastic deformation are examined and the activation energies for ionic motion determined. It is found that up to 4% plastic deformation produces no change in the activation energy over the undeformed specimens, whereas deformations above 10% produce a decrease of about 0.2 eV. After such deformation, structure normally present in the $\ln(IT)$ vs T^{-1} plot is absent and the decrease in activation energy can be attributed to the generation of ion vacancies not associated with divalent impurities. Measurements on a deformed and annealed specimen support this view. (auth)

18602 NUCLEAR MAGNETIC SPECIFIC HEAT IN TWO FERROMAGNETIC IRON ALLOYS. C. T. Wei (Michigan State Univ., East Lansing), C. H. Cheng, and Paul A. Beck. *Phys. Rev.*, 122: 1129-30 (May 15, 1961).

From the nuclear magnetic specific heat, measured at 1.6 to 4.2°K, H_{eff} at the Co nuclei in $\text{Co}_{0.3}\text{Fe}_{0.7}$ is calculated to be 312 kgauss, while H_{eff} at the V nuclei in $\text{V}_{0.33}\text{Fe}_{0.67}$ is 61 kgauss or less. Both of these alloys are body-centered-cubic and ferromagnetic. The large difference in the H_{eff} values may be associated with the fact that in $\text{Co}_{0.3}\text{Fe}_{0.7}$, the Co^{59} nucleus is located in an atom with appreciably polarized 3d electrons, while in $\text{V}_{0.33}\text{Fe}_{0.67}$ the V^{51} nucleus is the only abundant nuclide with a nuclear magnetic moment and the atomic moment of V is very small or zero. In ferromagnetic alloys the polarization of the core s electrons is expected to be much stronger in those atoms that do have polarized d electrons than in adjacent atoms that do not. The results therefore suggest that, in the alloys investigated, the dominant contribution to H_{eff} arises through Fermi contact interaction from the polarization of the Co and V core s electrons. (auth)

18603 SCATTERING OF ELECTRONS BY PHONONS AND IMPURITIES IN SEMICONDUCTORS. H. Reiss and A. I. Anderman (Atoms International, Canoga Park, Calif.). *Phys. Rev.*, 122: 1135-40 (May 15, 1961).

A theory is developed for the mobility of an electron in an n-type semiconductor under the combined scattering of phonons and impurities. An attempt is made to combine the two processes in a rigorous manner by treating the effects of impurities as though due to an applied external field. Although in principle a solution for any value of τ , the phonon scattering relaxation time, should be possible, this paper only arrives at a limiting law for the mobility at

small values of τ . In the region of applicability satisfactory agreement with experiment is achieved. (auth)

18604 PARAMAGNETIC RESONANCE OF Cr^{3+} IN YTTRIUM OXIDE. J. W. Carson, D. P. Devor, and R. H. Hoskins (Hughes Research Labs., Malibu, Calif.). *Phys. Rev.*, 122: 1141-3 (May 15, 1961).

The paramagnetic resonance spectrum of Cr^{3+} in single-crystal yttrium oxide is observed at microwave frequencies from 9 to 71 kMc at temperatures from 4.2 to 300°K. The spectrum is described in terms of the spin Hamiltonian $\mathcal{H} = g\beta H \cdot S + D[S_z^2 - S(S+1)/3]$, where $g = 1.97 \pm 0.01$, $S = 3/2$, and $2D = 72.9 \pm 0.2$ kMc at 300°K, and $2D = 72.7 \pm 0.2$ kMc at 77 and 4.2°K. (auth)

18605 COHERENCE EFFECTS IN RESONANCE FLUORESCENCE. M. E. Rose (Oak Ridge National Lab., Tenn.) and R. L. Carvillano. *Phys. Rev.*, 122: 1185-94 (May 15, 1961).

The crossed-level method of atomic spectroscopy is discussed. The angular distribution formula for both incoherent and coherent resonance scattering is derived. The form of this distribution function explicitly displays the geometric factors depending on radiation propagation vectors. With the application to hydrogen in mind, the distribution function is expressed explicitly for single electron transitions with external fields possessing axial symmetry. The properties of the distribution function are discussed with emphasis on the case of unpolarized radiation. For the case of hydrogen there are two applications of major interest. The first concerns the possibility of a precision measurement of the 2p fine structure splitting and, hence, a determination of the fine structure constant. Explicit results for the shape and other properties of the resonance line with a uniform magnetic field are obtained. The other application is concerned with the possibility of measuring the 2s-2p Lamb splitting. This requires an electric field parallel to the magnetic field. Unfortunately, the level crossings sensitive to the Lamb splitting cannot radiate sufficiently rapidly, while those that do radiate appreciably occur at field strengths which are extremely insensitive to the Lamb splitting. (auth)

18606 DISSOCIATION OF MOLECULAR IONS BY ELECTRIC AND MAGNETIC FIELDS. John R. Hiskes (Univ. of California, Berkeley). *Phys. Rev.*, 122: 1207-17 (May 15, 1961). (UCRL-9182(Rev.))

A discussion of the dissociation of diatomic molecules and molecular ions by electric fields is presented. Calculations are given that pertain primarily to the ground electronic states of the molecular systems. The H_2^+ ion is treated in detail; the required fields for its dissociation range from 10^6 v/cm for the uppermost vibrational state to 2×10^6 v/cm for the ground state. The many-electron homonuclear ions are treated in successive charge states. The HD^+ , HT^+ , HD , LiH^+ , and LiH^{++} heteronuclear ions are considered. The dissociation of homonuclear ions and heteronuclear ions exhibit distinctly different features. The HD^+ and HT^+ ions are more susceptible to analysis than is H_2^+ . The extent to which the dissociation by an electrostatic field and by the Lorentz force are equivalent is considered. The rates of induced dipole transitions to lower vibrational states can be made negligibly small compared with the dissociation rates. Applications to particle accelerators and to the injection problem for fusion devices are discussed. (auth)

18607 THE 2^3S EXCITATION IN HELIUM. G. S. Higginson and L. W. Kerr (Queen's Univ., Belfast). *Proc. Phys. Soc. (London)*, 77: 866-8 (Apr. 1, 1961).

A simple diffusion method is employed to measure the shape of the excitation probability curve above the threshold of the 2^3S excitation in helium. (auth)

18608 TWO-ELECTRON MATRIX ELEMENTS FOR ENERGY OPERATOR IN J1-COUPPLING. Ya. I. Vizbaraite, I. I. Vosilyus, A. Yu. Savukinas, and A. P. Yutsis (Inst. of Physics and Mathematics, Academy of Sciences, Lithuanian SSR and Vilnyus State Univ., [USSR]). *Trudy Akad. Nauk Litovskoi S.S.R.*, Ser. B, No. 1, 23-48(1961). (In Russian)

Matrix elements for j1-coupling are expressed by 6 j-coefficients. Expressions are derived for electrostatic and spin-orbit interaction energy. Tables of coefficients for energy expressions for configurations sl, pp, pd, pg, dd, df, and dg are included. (tr-auth)

18609 TWO-ELECTRON MATRIX ELEMENTS FOR ENERGY OPERATOR FOR LS-COUPPLING. S. A. Zhvironaite, Ya. I. Vizbaraite, and A. P. Yutsis (Inst. of Physics and Mathematics, Academy of Sciences, Lithuanian SSR and Vilnyus State Univ. [USSR]). *Trudy Akad. Nauk Litovskoi S.S.R.*, Ser. B, No. 1, 49-64(1961). (In Russian)

A mathematical apparatus is developed for calculating the two-electron system for Ls-coupling where the orbital quantum number of both electrons in L are first combined, then the spin moments are added. The coefficients in the radial integrals of expressions for the energy operator matrix elements in spin-orbit and in electrostatic interactions for configurations sl, pp, pd, pf, pg, dd, df, and dg are quoted. (tr-auth)

18610 EXCITATION AND DETERIORATION OF THE LUMINESCENCE OF CaWO_4 AND ZnS(Ag) BY IONS. Gerhard Döll (Universität, Giessen, Ger.). *Z. Physik*, 162: 215-28(1961). (In German)

The luminescence response of ZnS(Ag) and CaWO_4 to ion bombardment and the deterioration of luminescence under prolonged irradiation was determined as a function of ion energy E, ion mass M_i and beam density I. The variation of light output with ion energy is of the form $J_0 = C \times (E - E_0)^n$ with $n = 2$ (ZnS(Ag)) or lower values (CaWO_4). The luminescence response to ions of various mass was found to decrease generally with growing mass, but to be nearly constant to ions of middle atomic weight (ZnS(Ag)). The luminescence efficiency, caused by ions of energy greater than 5 kev, is independent of beam density within the whole range studied (maximum 3×10^{-7} A cm^{-2}), but it diminishes in the case $E = 5$ kev for values of I above 6×10^{-8} A cm^{-2} . The deterioration effect grows, except in the case of He^+ ions, the lightest ions used, with ion energy. It also increases by substituting Ne^+ for He^+ ions, but remains nearly independent of mass (CaWO_4) or diminishes with growing ion-mass (ZnS(Ag)), if the ions are heavier than Ne^+ ions. Increasing beam density leads to a reduced deterioration of ZnS(Ag) luminescence, yet has no influence on that of CaWO_4 . (auth)

18611 THE THERMAL IONISATION AND THE ELECTROCONDUCTIVITY OF THE GASEOUS MIXTURE. Yu. V. Sanochkin (Mathematical Inst., Moscow). *Zhur. Tekh. Fiz.*, 31: 188-93(Feb. 1961). (In Russian)

The thermal ionization of gas mixtures is analyzed and general formulas are developed considering the first and subsequent ionizations. The obtained data are used for evaluating the variations in electric conductivity resulting from gaseous admixtures. Calculations are made of the degree of ionization and electric conductivity behind a shock wave in argon with various amounts of cesium and aluminum. The structure of the shock wave was also studied. The results are in good agreement with available data. (R.V.J.)

18612 INVESTIGATION OF THE CURRENT DISTRIBUTION IN THE ION-BEAM. S. N. Popov (Inst. of Chemi-

cal Physics, Moscow). *Zhur. Tekh. Fiz.*, 31: 217-23(Feb. 1961). (In Russian)

The current density distribution in an ion beam is close to the Gauss error curve. The ion beam pulsates with a frequency equal to the frequency of acceleration. An attempt is made to explain the pre-axial density peak and pre-axial luminescence. It is postulated that the diameter of the ion beam corresponds to the diameter of the visual (luminescent) beam. (tr-auth)

18613 GASES AT HIGH DENSITIES AND TEMPERATURES. Yu. N. Ryabinin. Translated by H. K. Zienkiewicz from "Gazy pri bol'shikh Plotnostyakh i Vysokikh Temperaturakh," Moscow, Fizmatgiz, 1959. New York, Pergamon Press, 1961. 58p. \$4.50.

Experiments are described in which gases are isentropically compressed. Very high temperatures and pressures are reached simultaneously, up to 10^4 kg/cm² and 9000°K depending on the gas used. Thermodynamic characteristics, radiation spectra, and electric conductivity are studied; both monatomic and polyatomic gases are used. (T.F.H.)

18614 ADVANCES IN CRYOGENIC ENGINEERING. VOLUME 6. Proceedings of the 1960 Cryogenic Engineering Conference, University of Colorado and National Bureau of Standards, Boulder, Colorado, August 23-25, 1960. K. D. Timmerhaus, ed. New York, Plenum Press, Inc., 1961. 668p. \$15.00.

Sixty-seven papers are included. Subjects discussed include space technology, superconductivity, production and handling processes, transfer characteristics, physical equilibria and related properties, heat transfer and thermometry, mechanical properties, and equipment and applications. Separate abstracts have been prepared for 8 of the 67 papers included in the proceedings. (T.F.H.)

18615 STATUS OF ELECTRIC PROPULSION SYSTEMS FOR SPACE MISSIONS. W. E. Moeckel (Lewis Research Center, Cleveland). p.3-19 of "Advances in Cryogenic Engineering. Volume 6." K. D. Timmerhaus, ed. New York, Plenum Press, Inc., 1961.

The technological status of electrical propulsion systems is summarized, and the current and future space-mission possibilities of these systems are discussed. The system is divided into an energy generator and a thrust generator; and the thrust generators are classified as electrothermal, electrostatic, and electromagnetic types. The performance of an electrical propulsion unit is described in a 24-hour satellite mission and in a manned or unmanned interplanetary probe mission. (T.F.H.)

18616 PRINCIPLE OF A LIQUID NITROGEN IRRADIATION DEVICE AND ITS REALIZATION FOR USE IN A SWIMMING-POOL TYPE REACTOR. L. Bochirol, J. Doulat, and L. Weil (Centre d'Etudes Nucléaires, Grenoble, France). p.130-5 of "Advances in Cryogenic Engineering. Volume 6." K. D. Timmerhaus, ed. New York, Plenum Press, Inc., 1961.

A liquid nitrogen cooling system is described for use in in-pile irradiation loops. Since oxygen impurities in the presence of γ fluxes tend to explode, a closed primary system of very pure nitrogen is used in the γ flux area. Outside the flux area, a secondary liquid nitrogen circuit of commercial purity is used to cool the primary circuit. The system is designed such that pure nitrogen is evaporated and reliquefied within the pile; the flow is provided by gravity, and no moving parts are necessary. (T.F.H.)

18617 SUPERCONDUCTING MAGNETS. V. D. Arp and R. H. Kropschot (National Bureau of Standards, Boulder,

Colo.). p.166-73 of "Advances in Cryogenic Engineering. Volume 6." K. D. Timmerhaus, ed. New York, Plenum Press, Inc., 1961.

Uses of superconducting metals or alloys as current-carrying elements of electromagnets are studied. It is noted that the critical magnetic field is the limiting factor in the use of these superconductors. A technique is described for attaining fields up to 25 kgauss by using niobium with an iron core. In general, for fields greater than 20 kgauss, it is suggested that thin superconducting films of thickness less than λ (= penetration depth) be used, because these thin films have a much higher critical field than usual wires. (T.F.H.)

18618 EXPLOSION HAZARDS OF LIQUID HYDROGEN. M. G. Zabetakis, A. L. Furno, and G. H. Martindill (Bureau of Mines, Pittsburgh). p.185-94 of "Advances in Cryogenic Engineering. Volume 6." K. D. Timmerhaus, ed. New York, Plenum Press, Inc., 1961.

The nature and extent of hazards involved in the use of liquid H are investigated, as well as emergency procedures and safeguards. The hazards are classified as liquefaction (of air in liquid H), vaporization, formation of flammable mixtures, and ignition and combustion of air-H mixtures. The chief hazards are formation of shock-sensitive liquid H-solid air mixtures and fire. A table of distances from inhabited buildings and an intertank separation formula for H storage are given. (T.F.H.)

18619 STUDIES OF THE LOW-TEMPERATURE DISTILLATION OF HYDROGEN ISOTOPES. T. M. Flynn (National Bureau of Standards, Boulder, Colo.). p.236-44 of "Advances in Cryogenic Engineering. Volume 6." K. D. Timmerhaus, ed. New York, Plenum Press, Inc., 1961.

A hydrogen distillation pilot plant is described, for separation of H_2 from HD. Sieve plates are used in the distillation columns. The over-all, Murphree plate, and Murphree point efficiencies of the system are compared, and relations between these efficiencies are derived. It is found that the efficiency does not depend strongly either on plate type (sieve or bubble cap) or on column diameter. (T.F.H.)

18620 A HELIUM³ REFRIGERATOR. C. J. Rauch (Massachusetts Inst. of Tech., Lexington). p.345-53 of "Advances in Cryogenic Engineering. Volume 6." K. D. Timmerhaus, ed. New York, Plenum Press, Inc., 1961.

A refrigerator using He^3 as the refrigerant and He^4 at 1.4°K as the condenser is described. The lowest temperature that can be reached with the system is about 0.4°K. The refrigeration is calculated from a He^3 temperature-entropy diagram below 2°K, and compared with the actual refrigeration. (T.F.H.)

18621 A METHOD AND APPARATUS FOR CONCENTRATING TRACE IMPURITIES IN ANALYZING GRADE-A HELIUM. C. G. Kirkland, L. W. Brandt, and W. M. Deaton (Bureau of Mines, Amarillo, Tex.). p.399-405 of "Advances in Cryogenic Engineering. Volume 6." K. D. Timmerhaus, ed. New York, Plenum Press, Inc., 1961.

An apparatus is described for separating and determining trace impurities in Grade-A Helium (less than 50 ppm impurity content). The impurities are frozen out in a coil-and-trap assembly at liquid He temperatures, and are concentrated by a factor of from 25,000 to 100,000. Mass spectrographic methods are then used to find each original impurity content within 0.05 ppm. H_2 , CH_4 , Ne, N_2 , O_2 , Ar, CO_2 , and other impurities can be determined by this method. (T.F.H.)

18622 LOW-TEMPERATURE RESEARCH ON TRANSURANIC METALS. K. Mendelssohn (Oxford Univ.). p.622-

6 of "Advances in Cryogenic Engineering. Volume 6." K. D. Timmerhaus, ed. New York, Plenum Press, Inc., 1961.

Techniques for studying the cryogenic properties of Pu, Np, and other transuranic elements are described. Two methods for dealing with the radioactivity of these elements are outlined. The samples may either be encapsulated and studied in a conventional cryostat, or examined in a specially designed glove box. The electric resistivities of Np, Pu, and Al-Pu alloys are shown as functions of temperature from 1.5 to 300°K. The results are explained in terms of phase transitions and spin ordering. (T.F.H.)

Astrophysics and Cosmology

18623 (LAMS-2515) NUCLEAR POWERED LUNAR ROCKETS. Ralph S. Cooper (Los Alamos Scientific Lab., N. Mex.). Dec. 1960. Contract W-7405-eng-36. 33p.

Vehicle sizes were estimated for a minimum manned lunar expedition assuming a wide variety of vehicle configurations using chemical and/or nuclear propulsion. For a fixed payload of 55,000 pounds landed on the moon, take-off weights range from 720,000 to 13 million pounds while propellant volumes vary only over a factor of 3. All-chemical rockets weigh of the order of 10 million pounds, which is reduced to about 4 million with the use of one nuclear stage and to 1 or 2 million with two nuclear stages. The most interesting case is a 1.66×10^6 pound chemically boosted vehicle with two nuclear upper stages, the larger requiring only a 10,000 Mw reactor. A ground launched nuclear booster for this mission would require a reactor of at least 25,000 Mw power level. The general results indicate that the use of even one nuclear stage greatly reduces the weight and size of the vehicle required for this mission. While all-nuclear rockets have the smallest take-off weight, hybrid vehicles have the smallest dimensions and smallest manufactured weights. (auth)

18624 (NP-10153) ASTRONAUTICS INFORMATION ABSTRACTS, VOL. III, NO. 4. B. J. Hardgrove, E. H. Sands, and F. L. Warren, comps. (California Inst. of Tech., Pasadena. Jet Propulsion Lab.). Apr. 1961. Contract NASw-6. 48p.

This issue contains Abstracts No. 3,396 to 3,496 and covers space flight and applicable data and techniques. (D.L.C.)

18625 SCATTERING OF RADIO WAVES BY AN IONIZED GAS IN THERMAL EQUILIBRIUM IN THE PRESENCE OF A UNIFORM MAGNETIC FIELD. J. A. Fejer (Defence Research Board Theoretical Studies Group, Ottawa). Can. J. Phys., 39: 716-40(May 1961).

A theory is developed for the scattering of radio waves by the electron density fluctuations that exist in an ionized gas in thermal equilibrium. The theory, treats the range of the "characteristic scale" of the scattering irregularities from very much larger to very much smaller than the Debye length. The presence of several types of ions are considered and the ion and electron temperatures are not assumed equal. The effects of an external magnetic field are taken into account. It is shown that the total power is independent of the magnetic field. An expression for the frequency spectrum of scattered power in the presence of a uniform magnetic field is obtained. Useful approximations to this expression are derived for various limiting cases of interest. It is concluded that the magnetic field need not be taken into account, except at great heights.(auth)

18626 THE RECORD IN THE METEORITES. V. A. THERMOMETER MINERAL IN THE MIGHEI CARBONA-

CEOUS CHONDRITE. E. R. DuFresne and E. Anders (Univ. of Chicago). (EFINS-60-33). *Geochim. et Cosmochim. Acta*, 23: 200-8(May 1961). (In English)

Mighei contains submicrogram fragments of strained glass of refractive index 1.55 which can be annealed at temperatures below 300°C. The time-temperature curve for annealing is determined, and serves as an upper boundary for the thermal experiences of the meteorite since the time its constituent minerals were brought together. Mighei cannot have been heated to 180°C for more than a few weeks, to 250°C for more than a fraction of an hour, and can never have been heated to 300°C. Hypotheses concerning the origin of the glass are presented: Their common element is the action of aqueous solutions. It is shown that thermal action alone is inadequate. (auth)

18627 RADIOACTIVE SPECIES PRODUCED BY COSMIC RAYS IN THE AROOS IRON METEORITE. Masatake Honda and James R. Arnold (Univ. of California, La Jolla). *Geochim. et Cosmochim. Acta*, 23: 219-32(May 1961). (In English)

The iron meteorite Aroos fell on 24 November 1959. Using a sample received in February 1960, the content of eighteen cosmic-ray produced radioactive nuclides in this meteorite is measured. All were separated by wet chemical methods. A low-level x-ray proportional counter was used for a group of electron-capture species; β - and γ -counting were used for the others. The activities of the long-lived species Be^{10} , Al^{26} and Mn^{53} were close to those found previously in the meteorites Williamstown and Grant. The value for Cl^{36} was also consistent with earlier work. Much less K^{40} was found, indicating a shorter cosmic-ray age for Aroos. Comparison of the activities of the groups $\text{Mn}^{53}-\text{Mn}^{54}$, $\text{Ti}^{44}-\text{Sc}^{46}-\text{Ca}^{45}$, $\text{Na}^{22}-\text{Al}^{26}$, and $\text{Cl}^{36}-\text{Ar}^{37}-\text{Ar}^{39}$ (data of Fireman and de Felice, 1960) indicates constancy of the cosmic-ray flux over millions of years within a factor of 2 or 3. Comparison of the groups $\text{Mn}^{54}-\text{V}^{49}-\text{Na}^{22}$, and $\text{Ti}^{44}-\text{Si}^{32}$, among others shows the great importance of low-energy particles in synthesizing products close to the target mass. Quantitative discussions will be given in a later paper. (auth)

18628 THE SOURCE OF RADIATION FROM JUPITER AT DECIMETER WAVELENGTHS. III. TIME DEPENDENCE OF CYCLOTRON RADIATION. George B. Field (Princeton Univ., N. J.). *J. Geophys. Research*, 66: 1395-1405(May 1961).

Recent observations of the polarization, spectrum, spatial extent, and time variation of the Jovian decimeter emission are compared with the characteristics of a model based on cyclotron radiation by nonrelativistic electrons trapped in a dipole field. All characteristics but the observed time variation are consistent with a model in which the magnetic field strength at the equator is 0.6 gauss and that at the poles 1.6×10^5 gauss. The field extends to 50 Jovian radii and contains about 3×10^{-5} electrons per cubic centimeter if the electron energy is 40 kev. The problem of time variation is considered theoretically, account being taken of the effects of energy lost through radiation. In particular, the time dependence of the spectrum is calculated for a case when the electrons are injected instantaneously with a given distribution of mirror points. Solutions for arbitrary time dependence of the injection are then found by superposition. The fundamental solution (for instantaneous injection) is found to decay rapidly (in a few days for Jupiter) from a spectrum characteristic of initial conditions to one independent of initial conditions. The observed spectrum of Jupiter cannot be due to the initial phase, because theory indicates that that phase would not last long enough; on the

other hand, it cannot be due to the later phase, because theory indicates a much steeper spectrum than is observed. The observed time variation can be reproduced theoretically by a suitable variation of electron injection, but again the theoretical spectrum is much steeper than is observed. It is concluded that the cyclotron model is ruled out by the observations. It seems possible that a model based on synchrotron emission can be made to explain the time variation while also fitting the other observed characteristics. (auth)

18629 INTERNAL STATE OF A GRAVITATING GAS. G. E. Tauber and J. W. Weinberg (Western Reserve Univ., Cleveland). *Phys. Rev.*, 122: 1342-65(May 15, 1961).

The significance of a theory of gravitational equilibrium of concentrated masses is discussed, in connection with possible general relativistic effects in white dwarf stars. The covariant form of phase space and Liouville's theorem is developed, using the canonical equations for a particle under gravitational and electromagnetic forces. The dynamical isotropy of the ideal fluid is formulated, and the associated equations of state and allowed streaming patterns are found. A covariant kinetic theory yields general relativistic forms for the Maxwell and Fermi distributions in the case of thermal equilibrium, and limits their streaming to rigid motion. Rotating fluids are studied in comoving coordinates, and the problem of determining their gravitational equilibrium is reduced, in most cases of physical interest, to a simple standard form with constant density and vorticity. (auth)

Cosmic Radiation

18630 (INS-13) COSMIC RADIATION FROM THE HORIZON. M. Oda (Tokyo Univ. Inst. for Nuclear Study), T. Oshio, K. Watanabe, and Y. Watase (Osaka City Univ.). [nd]. 3p.

A discussion is given for the production of high-energy μ -mesons from the decay of π - and K-mesons decaying in flight in the atmosphere. The production rate, during the earlier processes of the nucleon cascade in the atmosphere, is about eight times higher for directions from 0 to 5° above the horizon than that for the more or less vertical direction. Suggestions are given for experiments on μ -mesons of energies 10^{12} to 10^{13} ev for intensity-depth relations and a momentum analyzer. (B.O.G.)

18631 (NP-9546) SOVIET RESEARCH IN COSMIC RAY PHYSICS. (Office of Technical Services, Washington, D. C.). Apr. 30, 1959. 9p. (PB-60-21922)

An evaluation of Soviet cosmic-ray research is presented. Soviet theoretical study of the origin and variations of cosmic rays is notable. Experimental research in the USSR is technically competent but lacking in imagination. A technical competence in use of rockets and satellites has been demonstrated, hence they may attain a lead in cosmic-ray effects on life in outer space. Soviet emphasis on cosmic ray research is increasing. (T.R.H.)

18632 THE EFFECTIVE DIRECTIONAL SENSITIVITY OF COSMIC RAY NEUTRON MONITORS. S. M. Lapointe (Univ. of Montreal) and D. C. Rose. *Can. J. Phys.*, 39: 668-76(May 1961). (NRC-6269).

The direction of maximum sensitivity of a cosmic neutron monitor is calculated numerically for a set of points on the same geomagnetic meridian but extending in latitude from the equator to the pole. This calculation leads to two master curves, one for the longitude, the other for the latitude of this direction. From these curves this direction is obtained in geographic co-ordinates for some 20 cosmic-

ray stations. The method of calculation is described taking into account atmospheric absorption and the energy spectrum of the incident particles. The aperture of the sensitive cone or source width, is also calculated. The application of the concept of effective direction is described. (auth)

18633 THE RING CURRENT, GEOMAGNETIC DISTURBANCE, AND THE VAN ALLEN RADIATION BELTS. Syun-Ichi Akasofu (Univ. of Alaska, College). *J. Geophys. Research*, 66: 1321-50 (May 1961).

The large decrease in the horizontal component of the earth's field during the main phase of magnetic storms is ascribed to the formation or enhancement of a geomagnetic ring current. The motions of particles trapped in the earth's dipole field and the resulting ring current are discussed. These calculations deal only with a steady state, though during storms the state is changing. The general equations for the current intensity, to obtain the total current and the magnetic field at the earth's center, are applied to the outer radiation belt (V_2) and to a special 'model' belt V_3 . This V_3 belt has a particular type of pitch-angle distribution and a number-intensity distribution of Gaussian type along an equatorial radius. The results are considered in connection with magnetic records for several storms and with satellite data. It is inferred that, during magnetic disturbance, protons of energy of the order of a few hundred kev are intermittently captured between 5 and 8 earth radii and that they produce a transient belt V_3 . The variety of development of the ring current from one storm to another may be connected with irregularities in the distribution of particles in the solar stream, which may contain tangled magnetic fields. (auth)

18634 THE EFFECTS OF BETATRON ACCELERATIONS UPON THE INTENSITY AND ENERGY SPECTRUM OF MAGNETICALLY TRAPPED PARTICLES. Paul J. Coleman, Jr. (Space Technology Labs., Inc., Los Angeles). *J. Geophys. Research*, 66: 1351-61 (May 1961).

A system composed of relativistic, charged particles in a uniform, slowly varying magnetic field is considered. The initial or unperturbed state of the system is one in which the number of particles per cubic centimeter with energies greater than E is given by $kE^{-\gamma}$, and in which the particle flux is isotropic. The effects of slow, uniform changes in the field strength upon the integral energy spectrum and upon the omnidirectional intensity of particles with momenta greater than σ are calculated. A simple expression which describes the latter effect is developed. Variations of these two effects are calculated as functions of the parameters, γ and σ . (auth)

18635 CHARACTERISTICS AND FINE STRUCTURE OF THE LARGE COSMIC-RAY FLUCTUATIONS IN NOVEMBER 1960. J. F. Steljes (Atomic Energy of Canada Ltd., Chalk River, Ont.), H. Carmichael, and K. G. McCracken. *J. Geophys. Research*, 66: 1363-77 (May 1961).

Measurements obtained at Deep River, Canada, from two large neutron monitors, and at Cambridge, Massachusetts, from a high counting rate meson monitor, during the solar cosmic-ray injections of November 12 and 15, 1960, are reported. In addition, rate-meter pen traces of the neutron increases and a magnetometer trace of H , obtained at Deep River, are reproduced. The solar cosmic-ray increase of November 12 appears to be unique in that while it was in progress a sharp Forbush decrease happened to occur as shown by the MIT meson intensity. Half an hour before the onset of the Forbush decrease, and coincident with a conspicuous increase of H , the intensity of the solar cosmic radiation doubled and then exhibited strong rapid

oscillations. Arguments are advanced that the changes of intensity of the solar cosmic rays observed at high latitudes at the time of the magnetic disturbance and Forbush decrease are due to the earth sampling solar cosmic rays trapped in the gas cloud responsible for these latter effects. The events of November 12 and 15 are both shown to be in agreement with a recent model for the magnetic fields in the inner solar system. At the time of the solar cosmic-ray increase of November 15, the earth was already inside a trapping region, and periodic oscillations of the solar cosmic-ray intensity were observed lasting for about 2 hours. It is suggested that these oscillations may be closely connected with the storage mechanism. (auth)

18636 BALLOON OBSERVATIONS OF AURORAL-ZONE X RAYS. R. R. Brown (Univ. of California, Berkeley). *J. Geophys. Research*, 66: 1379-88 (May 1961).

A series of balloon flights launched from the vicinity of College, Alaska, during June and July 1960 show that auroral-zone x rays are detectable with Geiger counters approximately 10% of the time at pressure altitudes in the range 10 to 15 mb. The results of these flights indicate that the daily flux of electrons with energies greater than 50 kev over the auroral zone is 6×10^{10} particles/cm². Late in a magnetic storm that started with a sudden commencement at 1701 UT on July 14, 1960, the average electron influx exceeded the daily rate by more than a factor of 25. (auth)

18637 SEASONAL VARIATIONS OF COSMIC RAY INTENSITY IN POLAR REGIONS. K. Maeda and V. L. Patel (Univ. of Maryland, College Park). *J. Geophys. Research*, 66: 1389-93 (May 1961).

A seasonal variation of cosmic-ray intensity was observed at two opposite polar stations, one at Thule in Greenland and the other at Wilkes in Antarctica. They are in antiphase, with a maximum in local winter. The seasonal variation can be accounted for almost completely by atmospheric effects, although a small extraterrestrial contribution cannot yet be excluded. Abnormally large values for the atmospheric temperature effects at these stations (a coefficient $-8.3 \pm 0.9\%$ km for the reference level of 300 mb at Thule and $-12.5 \pm 2.1\%$ km at Wilkes) are found. This can be ascribed to a low altitude of the effective muon-production level in polar regions. (auth)

18638 THE COUPLING BETWEEN THE PROTONOSPHERE AND THE NORMAL F REGION. W. B. Hanson and I. B. Ortenburger (Lockheed Missiles and Space Div., Sunnyvale, Calif.). *J. Geophys. Research*, 66: 1425-35 (May 1961).

The proton distribution in the upper portion of the F_2 region must follow a chemical equilibrium distribution up to a critical level, h_c , which is determined by the condition $\lambda\Lambda = H^2$, where λ is the mean free path for the scattering of protons by oxygen ions, Λ is the charge-exchange mean free path for protons among oxygen atoms, and H is the scale height of atomic oxygen. Above this critical level, the distribution of protons is governed by diffusion. The number of protons in the whistler medium (that is, the protonosphere) is large enough, and the rate of diffusion of protons through oxygen ions slow enough, so that no large diurnal changes in whistler-region ion concentrations can be expected. This is in agreement with observation. The weak coupling between the oxygen ions in the normal F_2 region and the protons in the protonosphere lends support to the position that the protonosphere should be considered separately from the heavy-ion region which constitutes the normal ionosphere; the protonosphere can

be thought of, in large degree, as floating on top of the normal ionosphere. (auth)

18639 SOLAR FLARE COSMIC-RAY EVENT OF MAY 4, 1960. K. Maeda, V. L. Patel, and S. F. Singer (Univ. of Maryland, College Park). *J. Geophys. Research*, 66: 1569-72 (May 1961).

A sudden increase of cosmic-ray intensity was observed May 4, 1960, at approximately 10:30 UT by several cosmic-ray detectors. This increase was due to the production of high-energy-charged particles near the sun associated with solar flares of importance plus three observed near the west limb of the sun at 10:15 UT. (N.W.R.)

18640 ORIGIN OF COSMIC RAYS. J. N. Tandon (Univ. of Delhi). *Nature*, 190: 246-7 (Apr. 15, 1961).

Various theories on the origin of cosmic rays are reviewed. It is suggested that flares in dwarf red stars may be the source of cosmic ray generation. It is pointed out that the flare phenomenon on such stars is of the same general character as on the sun, but more energetic. The total energy of a red dwarf flare was calculated to be in excess of 3×10^{36} ergs. It is concluded that the red dwarf stars supply sufficient energy to maintain dynamic equilibrium of cosmic rays in our galaxy. (C.H.)

18641 PRIMARY COSMIC-RAY α -PARTICLES. I. A. Engler (Univ. of Rochester, N. Y.), M. F. Kaplon, A. Kernan, J. Klarmann, C. E. Fichtel, and M. W. Friedlander. *Nuovo cimento* (10), 19: 1090-9 (Mar. 16, 1961). (In English)

The primary cosmic α -particle energy spectrum is investigated, using photographic emulsions exposed on July 30th, 1957. The total flux observed is (151 ± 9) particles/cm². sr. sec. The differential energy spectrum shows a broad maximum between 400 and 600 Mev/nucleon, and appears different in shape from the spectrum observed at solar minimum. No particles are observed to have kinetic energies below 200 Mev/nucleon, but a substantial flux is observed between 200 and 300 Mev/nucleon. From the centered dipole approximation to the geomagnetic field, a cut-off energy is expected at this latitude of 292 Mev/nucleon. The results are in disagreement with this figure. (auth)

18642 THE HEAVY COMPONENT OF THE PRIMARY COSMIC RADIATION DURING SOLAR MAXIMUM. C. E. Fichtel (Washington Univ., St. Louis). *Nuovo cimento* (10), 19: 1100-15 (Mar. 16, 1961). (In English)

The heavy component of the primary cosmic radiation was studied at geomagnetic latitude 55° N at a time of solar maximum. The total flux was found to be about a factor of two lower than that obtained during solar minimum, but the charge spectrum was found to be the same, within experimental errors. The extrapolated fluxes at the top of the atmosphere were found to be: (3.08 ± 0.64) part./m². sr. sec for $3 \leq Z \leq 5$; (8.26 ± 0.82) part./m². sr. sec for $6 \leq Z \leq 9$; and (2.96 ± 0.49) part./m². sr. sec for $10 \leq Z$. When these data were combined with those obtained at different latitudes and compared to the data obtained at solar minimum, the change in the integral spectrum was found to be in fair agreement with the predictions of an electric deceleration modulating mechanism. (auth)

18643 PHOTOSTAR CROSS SECTION FROM COULOMB DISINTEGRATIONS OF HIGH ENERGY HEAVY PRIMARIES. S. T. Butler and C. A. Pearson (Univ. of Sydney). *Nuovo cimento* (10), 19: 1266-8 (Mar. 16, 1961). (In English)

The photostar production process in nuclear emulsions is studied. Heavy primary cosmic nuclei at energies of $\sim 10^{12}$ ev/nucleon may undergo reactions in emulsion that

are similar to photostar production processes at energies of 0.2 to 25 Bev. The Coulomb disintegration cross section is calculated under various assumptions as to the photostar production cross section and as functions of primary size and energy. It is noted that a study of the Coulomb disintegration cross section of heavy primaries above 10^{12} ev/nucleon provides information concerning the photostar production cross section above 1.1 Bev. (T.F.H.)

18644 PRIMARY COSMIC RAYS. J. R. Winckler (Univ. of Minnesota, Minneapolis). *Radiation Research*, 14: 521-39 (May 1961).

Intensity fluctuations from galactic and solar cosmic radiation are discussed on the basis of data obtained from space measurements. The energy spectrum and primary particle composition deduced from these measurements are described. The data were obtained from 1952 through May of 1960. (N.W.R.)

18645 CORPUSCULAR RADIATIONS IN SPACE. James A. Van Allen (State Univ. of Iowa, Iowa City). *Radiation Research*, 14: 540-50 (May 1961).

The current state of knowledge of the energetic particles trapped in the magnetic field of the earth is discussed. The discussion is centered around the following topics: nature, composition, exposure levels, origin, and loss of trapped particles. Also discussed is space flight and radiation damage to electronic and other physical equipment. (N.W.R.)

18646 ON THE AZIMUTHAL ANGULAR DISTRIBUTION OF SHOWER PARTICLES. V. M. Chudakov (Inst. of Physics and Technology, Academy of Sciences, Uzbek, SSR). *Zhur. Eksptl' i Teoret. Fiz.*, 40: 156-62 (Jan. 1961). (In Russian)

It is shown that the χ^2 criterion can be employed to investigate the azimuthal angular distribution of a small number of shower particles. The azimuthal angular distribution of secondary particles in "jets" produced in photographic emulsions by cosmic ray particles is analyzed by the method proposed. It is concluded that peripheral collisions of high energy nucleons play an important role. (auth)

18647 THE ALTITUDE DEPENDENCE OF EXTENSIVE ATMOSPHERIC SHOWERS. E. V. Gedalin (Inst. of Physics, Academy of Sciences, Georgian SSR). *Zhur. Eksptl' i Teoret. Fiz.*, 40: 178-9 (Jan. 1961). (In Russian)

The altitude dependence of extensive atmospheric showers is considered by assuming that the absolute amount of energy transferred to π -mesons in collisions between nucleons with energies $E \approx 10^{12}$ ev and nuclei is constant (in the c.m.s.). It is shown that in order to obtain agreement between the results and the experimental data one is forced to assume that in secondary interactions involving particles other than π -mesons which carry off most of the energy in nucleon-nucleus encounters, a constant fraction of the incident particle energy is imparted to the π -mesons. (auth)

18648 OBSERVATION OF NUCLEAR-ACTIVE PARTICLES AND ELECTRON-PHOTON SHOWERS WITH ENERGIES $> 10^{12}$ eV AT AN ALTITUDE OF 3860 M ABOVE SEA LEVEL. E. V. Denisov, V. I. Zatsepin, S. I. Nikol'skii, A. A. Pomarnskii, B. V. Subbotin, E. I. Tukish, and V. I. Yakovlev (Lebedev Inst. of Physics, Academy of Sciences, USSR). *Zhur. Eksptl' i Teoret. Fiz.*, 40: 419-25 (Feb. 1961). (In Russian)

An experimental arrangement for studying the interaction between nuclear-active particles possessing energies $> 10^{12}$ ev and the nuclei of air and carbon nuclei is described. Preliminary results pertaining to the energy spec-

trum of nuclear active particles with energies $>10^{12}$ ev are discussed. (auth)

Criticality Studies

18649 (CF-61-4-33) NEUTRON MULTIPLICATION EXPERIMENTS WITH ENRICHED URANIUM METAL IN SLAB GEOMETRY. J. T. Mihalcz and J. J. Lynn (Oak Ridge National Lab., Tenn.). Apr. 10, 1961. 32p.

Critical thicknesses of uranium metal slabs enriched to 93.15% in the U^{235} isotope were obtained by a technique involving source-neutron multiplication counting. Subcritical assemblies of metal slabs were constructed to within, in most cases, 95% of critical mass, and the resulting reciprocal multiplication curves extrapolated to critical thicknesses. Slab dimensions ranged from 5×5 in. to 25×25 in., and thicknesses of infinite slabs were extrapolated from the data. Plexiglas, in thicknesses from 0 to 6 in., beryllium, and AGOT graphite served as neutron reflectors. Previous work with uranium-Plexiglas lattices was extended to lattice densities of 0.33 and 0.50, the latter being the limiting density under the conditions of the experiment. (auth)

18650 (NAA-SR-5584) HALLAM CRITICAL EXPERIMENT. R. J. Doyas (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). May 1, 1961. Contract AT-11-1-GEN-8. 34p.

The results of a critical-experiment program conducted to study the Hallam Nuclear Power Facility (HNPF) reactor concept and to verify design parameters are presented. Experimental procedures and results are given, and comparisons are made with calculational techniques currently in use for determining the nuclear characteristics of the HNPF reactor. (auth)

18651 MEASUREMENTS IN A SUBCRITICAL ASSEMBLY OF NATURAL URANIUM AND LIGHT WATER. M. A. Vigon and C. E. Granados (Junta de Energia Nuclear, Madrid). *Anales real soc. espan. fis. y quim* (Madrid), Ser. A, 56: 249-56 (Sept.-Oct. 1960). (In Spanish)

Some lattice parameters of a natural U, light water subcritical assembly were measured. Results obtained with and without radial reflector are compared. Values of B^2 for the bare assembly and reflector savings for the reflected assembly are given. Fine distribution of thermal flux throughout a cell was measured and k , the thermal utilization factor, determined. (auth)

18652 THERMAL UTILIZATION FACTOR CALCULATION IN HETEROGENEOUS LATTICES. V. C. Boffi and V. G. Molinari (CNEN, Rome). *Energia nucleare* (Milan), 8: 247-54 (Apr. 1961). (In English)

A formalism is developed to solve the equations of ordinary diffusion theory, to make possible calculation of the thermal utilization factor of a heterogeneous lattice, whose elementary cell consists of an arbitrary number of different regions. The introduction of a geometrically characteristic quantity leads to a recurrence formula for the thermal utilization factor, and for the coefficients of the equations governing the thermal flux distribution in each region. This formula is used for both plane and cylindrical geometries. (auth)

18653 THEORETICAL ANALYSIS AND EXPERIMENTAL RESULTS FOR C-H MODERATED ASSEMBLIES. G. B. Zorzi (CISE, [Milan]). *Energia nucleare* (Milan), 8: 255-60 (Apr. 1961). (In English)

A survey is made of the exponential experiments on natural uranium lattices having a hydrogenous moderator,

with particular reference to organic moderators. The measured bucklings for diphenyl moderated lattices appear to be high; a comparison is made between previous measurements and the experimental values obtained at CISE on impregnated graphite moderated lattices. A theoretical analysis confirms the presence of a systematic error in the measurements on diphenyl moderated lattices. This error can be shown to result from the contributions of spurious epithermal neutrons. (auth)

18654 LATTICES OF NATURAL URANIUM IN ORDINARY WATER. F. E. Prieto (Universidad Nacional Autonoma de Mexico) and G. S. de Oyarzabal. *Rev. mex. fis.*, 9: 213-54 (1960). (In Spanish).

The results of a first order nuclear calculation are presented for over one hundred natural uranium-light water subcritical lattices. Calculations are performed for a hexagonal geometry. The number of fission neutrons per captured thermal neutron is taken as 1.327; the thermal utilization factor, the resonance escape probability, and the fast fission factor are obtained. The infinite multiplication constant is obtained with the four-factor formula. For the migration area a formula proposed by Tavernier is used. The material and geometrical buckling as well as the external dimensions are obtained. Calculated values for the infinite multiplication constant, migration area, and material buckling are in agreement with experimental values. Curves are drawn relating uranium masses to amplification, and the effect of a light-water reflector is estimated. Finally, uranium masses are adjusted to the conditions of hexagonal geometry. (auth)

Elementary Particles and Radiations

18655 (AFOSR-97) ELECTRON-PROTON BREMSSTRAHLUNG. Technical Note No. 32. R. A. Berg and C. N. Lindner (Stanford Univ., Calif. Inst. of Theoretical Physics). Dec. 1960. Contract AF49(638)-388. 49p.

The electron-proton bremsstrahlung cross section is calculated in first Born approximation, neglecting radiative corrections to the electron. As an extension of an earlier calculation, the proton Compton effect contribution is analyzed in its most general form. It will involve twelve form factors of three invariants: $f_j(\nu_1, \nu_2, \nu_3)$, ($j = 1, \dots, 12$). The cross section is stated explicitly in terms of these twelve functions and the two form factors of one invariant describing the proton vertex. The contributions to the f_j from the single nucleon intermediate state, the one-meson, one-nucleon intermediate state, and the neutron pion exchange, are calculated. These three contributions are expected to be the major effects when the energies involved are in the range of present experimental interest. To order $(1/M)^2$, only three combinations of these twelve f_j will contribute to the cross section. When only the first two contributions are considered, only two of these three combinations are independent. Some numerical values for a bremsstrahlung coincidence experiment are presented. (auth)

18656 (IFA-EM-41) REMARKS ON UNUSUAL Σ^+ DECAYS. E. M. Friedländer (Academia R. P. R. Institutul de Fizica Atomica, Bucharest). [1961]. 2p.

A discussion is given concerning a common feature noted in three unusual events following nuclear interactions of K^- -mesons in emulsions leading to the emission of relatively slow π -mesons by a charged particle of apparently hyperprotonic mass. (B.O.G.)

18657 (TID-12608) THE EIGHTFOLD WAY: A THEORY OF STRONG INTERACTION SYMMETRY.

Murray Gell-Mann (California Inst. of Tech., Pasadena. Synchrotron Lab.). Mar. 15, 1961. 49p. (CTSL-20)

A new model of the higher symmetry of elementary particles is introduced in which the eight known baryons are treated as a supermultiplet, degenerate in the limit of unitary symmetry but split into isotopic spin multiplets by a symmetry-breaking term. The symmetry violation is ascribed phenomenologically to the mass differences. The baryons correspond to an eight-dimensional irreducible representation of the unitary group. The pion and K meson fit into a similar set of eight particles along with a predicted pseudoscalar meson χ^0 having $I = 0$. A ninth vector meson coupled to the baryon current can be accommodated naturally in the scheme. It is predicted that the eight baryons should all have the same spin and parity and that pseudoscalar and vector mesons should form octets with possible additional singlets. The mathematics of the unitary group is described by considering three fictitious leptons, ν , e^- , and μ^- , which may throw light on the structure of weak interactions. (D.L.C.)

18658 (UCRL-9548) π^+ -p TOTAL CROSS SECTIONS IN THE RANGE 450 Mev TO 1650 Mev (thesis). Thomas J. Devlin (California. Univ., Berkeley. Lawrence Radiation Lab.). Mar. 6, 1961. Contract W-7405-eng-48. 59p.

The total scattering cross sections for positive and negative pions on hydrogen was measured at intervals from 450 to 1650 Mev. Six scintillation counters measured the transmission of pions at various solid angles, and the results were extrapolated to zero solid angle. Two peaks previously discovered in the π^- -p cross section were measured and found centered at 600 ± 15 and 900 ± 15 Mev. A broad maximum was observed in the π^+ -p cross section at approx 1350 Mev. A "shoulder" at approximately 800 Mev, in a region where the π^+ -p cross section is rapidly rising, gives some support to speculation that there is a resonant state at this energy. (auth)

18659 CORRESPONDENCE PRINCIPLE APPROACH TO RADIATION THEORY. F. E. Low (Massachusetts Inst. of Tech., Cambridge). Am. J. Phys., 29: 298-9 (May 1961).

The classical law for the spontaneous radiation by a charged particle is expressed in such a way that its interpretation in terms of probabilities for transitions between stationary states is straightforward. (auth)

18660 THEORY OF BACKWARD SECONDARY EMISSION. Atsumi Kondo (Electrotechnical Lab., Tokyo). Denki Shikensho Ihô, 25: 67-74 (1960). (In English)

Backward secondary emission is considered on the basis of a certain emission mechanism. A general formula for the yield of backward secondary emission is derived, and the yield for a silver target foil is calculated as an example. The effect of the velocity spread of the primary electrons is omitted. (auth)

18661 THE UNIT OF NEUTRON FLUX. I. S. McGill, D. C. Menzies, and M. R. Price (United Kingdom Atomic Energy Authority, Thurso, Caithness, Eng.). Nature, 190: 162 (Apr. 8, 1961).

A unit of neutron flux, the chad, is defined as follows: 1 chad = 10^{12} n/cm² sec. The flux in most existing or contemplated power reactors lies in the range of 10^{12} to 10^{13} n/cm² sec, the flux in zero energy reactors is generally about 10^9 n/cm² sec, and that encountered in subcritical assemblies is approximately 10^6 n/cm² sec. High-flux research reactors operate at flux-levels ranging up to about 10^{16} n/cm² sec. The whole range of applied neutron physics

could therefore be covered conveniently by the chad, as defined above, and the associated units microchad (10^6 n/cm² sec), millichad (10^9 n/cm² sec), and kilochad. While having no objection in principle to the definition suggested earlier (1 chad = 1 n/cm² sec), the proposed definition is more practical and convenient in that, in addition to eliminating the clumsy compound nomenclature, it will remove the necessity for inclusion of large powers of 10. (auth)

18662 ABSOLUTE MEASUREMENT OF AVERAGE ENERGY LOST BY VERY SOFT X-RAYS PER ION PAIR IN AIR. B. Rajewsky and D. Lang (Max-Planck Institut für Biophysik, Frankfurt am Main). Nature, 190: 249-50 (Apr. 15, 1961).

Data are presented graphically from absolute measurements of the average energy lost by very soft x rays per ion pair produced in air. Results are compared with measurements of the average energy lost by photons and particles per ion pair produced in air. The measuring method is described. The mean value of W was found to be 35.0 ev. No significant dependence of W on quantum energy was found within the range 5.89 to 17.44 kev. (C.H.)

18663 INELASTIC π^- -NUCLEON INTERACTIONS AT 7.5 GeV. L. C. Grote, U. Krecker, U. Kundt, K. Lanus, G. Manske, and H. W. Meier (Kernphysikalisches Institut, Deutsche Akademie der Wissenschaften, Berlin). Nuclear Phys., 24: 300-12 (1961). (In English)

In a stack of NIKFI-R emulsions, irradiated with negative pions, 111 inelastic π^- -nucleon collisions are identified. The angular distribution of the emitted particles, their momenta, and their transverse momenta are investigated. The results show that the interactions can be partly ascribed to pion-pion collisions. For those collisions, the radius of the interaction volume is estimated to be $\Delta r_{\pi\pi} \approx 1.0 \times 10^{-13}$ cm. For the remainder of the pion-nucleon collisions $\Delta r_{\pi N} \approx 0.4 \times 10^{-13}$ cm is obtained. (auth)

18664 SEARCH FOR A NEUTRAL MESON OF ZERO I-SPIN. N. E. Booth, O. Chamberlain, and E. H. Rogers (Univ. of California, Berkeley). Nuovo cimento (10), 19: 853-63 (Mar. 1, 1961). (In English)

A search is made for a neutral meson of zero I-spin (π_0^0) by means of the reaction $d + d \rightarrow \text{He}^4 + \pi_0^0$. No evidence is found for the existence of the π_0^0 in the mass range from zero to 1.8 times the π^\pm mass. The upper limit of the cross section is $7 \cdot 10^{-32}$ cm² for π_0^0 mass $\approx \pi^\pm$ mass. The reaction is studied by using 460 Mev deuterons and a liquid deuterium target. α -particles produced at 0° in the laboratory system are selected by momentum analysis and by a counter telescope that measures time of flight, dE/dx , and differential range. The experiment may also set a limit on the validity of charge independence. (auth)

18665 A BUBBLE CHAMBER EXPERIMENT TO MEASURE THE POLARIZATION OF THE RECOIL PROTON IN THE PHOTOPRODUCTION OF π^0 -MESONS FROM HYDROGEN. L. Bertanza (Universita, Pisa, Italy and Istituto Nazionale di Fisica Nucleare, Pisa, Italy), P. Franzini, I. Mannelli, G. V. Silvestrini, and V. Z. Peterson. Nuovo cimento (10), 19: 953-7 (Mar. 1, 1961). (In English)

A rapid cycling bubble chamber is used to measure the polarization of the recoil proton from the reaction $\gamma + p \rightarrow \pi^0 + p$. The experimental setup and the method of analysis of the events are described. A preliminary result of the polarization is given for a mean photon energy of 725 Mev and a center of mass angle of 87° . (auth)

18666 π -N FORWARD DISPERSION RELATIONS WITH ELECTROMAGNETIC CORRECTIONS. A. Minguzzi

(CERN, Geneva). *Nuovo cimento* (10), 19: 981-6 (Mar. 1, 1961). (In English)

Meson-nucleon dispersion relations with an electromagnetic correction to e^2 (e = photon mass) order are proved, and a conjecture about the unphysical range absorptive part is discussed together with the Chew-Low extrapolation procedure. (auth)

18667 ON THE NUCLEAR CAPTURE OF NEGATIVE MUONS WITH ELECTRON EMISSION. M. Conversi, L. di Lella, A. Egidi, C. Rubbia, and M. Toller (Università, Rome and Istituto Nazionale di Fisica Nucleare, Rome). *Nuovo cimento* (10), 19: 987-98 (Mar. 1, 1961). (In Italian)

An experimental search is described for the neutrinoless μ^- capture reaction $\mu^- + N \rightarrow N + e^-$. μ^- mesons at 600 Mev stop in a copper target. The upper limit for the branching ratio of the process searched for, relative to ordinary muon capture, is improved by a factor of more than 20 with respect to previous measurements. (auth)

18668 EXPERIMENT ON THE PROCESS $\mu^- + N = e^- + N$. M. Conversi, L. di Lella, A. Egidi, C. Rubbia, and M. Toller (Università, Rome and Istituto Nazionale di Fisica Nucleare, Rome). *Nuovo cimento* (10), 19: 999-1009 (Mar. 1, 1961). (In Italian)

An experiment is performed on the process $\mu^- + N \rightarrow N + e^-$ making use of a low energy high intensity μ^- beam. If, as expected on theoretical ground, coherent neutrinoless capture of muons in copper is at least 6 times more probable than the corresponding incoherent process, the branching ratio relative to ordinary muon capture turns out to be less than 5.9×10^{-6} , with 90% confidence level. (auth)

18669 A SEARCH FOR THE DECAY $\Sigma^+ \rightarrow p + \gamma$. R. G. Glasser (U. S. Naval Research Lab., Washington, D. C.), N. Seeman, Y. Prakash, G. A. Snow, and P. Steinberg. *Nuovo cimento* (10), 19: 1058 (Mar. 1, 1961). (In English)

A search is reported for the decay $\Sigma^+ \rightarrow p + \gamma$, in emulsion stacks exposed to a 300 Mev/c K^- beam. A total of 16,327 K^- stars are analyzed. The expected length of the proton track from a $\Sigma^+ \rightarrow p + \gamma$ decay at rest is of the order of 3000 μ m; no protons of this range are observed. A total of 144 decays $\Sigma^+ \rightarrow p + \pi^0$ are found; it is suggested that these negative data be used to adjust the previously calculated value of the $(p + \gamma)/(p + \pi^0)$ branching ratio. (T.F.H.)

18670 RECOIL PROTON POLARIZATION IN π^- -p ELASTIC SCATTERING AT 600 Mev. P. Franzini and J. M. Gaillard (Columbia Univ., New York). *Nuovo cimento* (10), 19: 1062-4 (Mar. 1, 1961). (In English)

The angular distribution of the recoil proton polarization in π^- -p elastic scattering at 600 Mev is studied. The polarization angular dependences are calculated from 0 to 180°, assuming alternatively no resonance, a D-wave resonance with $T = \frac{1}{2}$ and $J = \frac{3}{2}$, or a P-wave resonance with $T = \frac{1}{2}$ and $J = \frac{3}{2}$. It is suggested that this angular dependence criterion be used to determine the actual nature of the resonance. (T.F.H.)

18671 A NETWORK APPROACH TO THE ANALYSIS OF ČERENKOV RADIATION PROBLEMS. COMMENT ON THE PAPER "ON THE THEORY OF SOME ČERENKOVIAN EFFECTS" BY G. TORALDO DI FRANCA. L. B. Felsen (Office of Naval Research, London) and A. Hessel. *Nuovo cimento* (10), 19: 1065-71 (Mar. 1, 1961). (In English)

Čerenkov radiation effects caused by the motion of charged particles in the vicinities of plane stratified dielectric media and plane diffraction gratings are studied. The excessive complexity involved in the evaluation of vector mode amplitudes is bypassed, by the use of network

concepts. These concepts lead quite directly to the modal representation, and allow straightforward methods to be used in accounting for the presence of perturbing objects. The approach is developed for isotropic media, it is noted that anisotropic media may also be treated in this manner. (T.F.H.)

18672 ON THE OBSERVATION OF FAST Σ -HYPERONS EMITTED FROM THE INTERACTIONS OF K^- -MESONS WITH EMULSION NUCLEI. B. D. Jones (H. H. Wills Physical Lab., Bristol, Eng.), B. Sanjeevaiah, J. Zakrzewski, P. G. Bizzeti, J. P. Lagnaux, M. René, M. J. Beniston, S. A. Brown, E. H. S. Burhop, D. H. Davis, D. Ferreira, E. Frota-Pessoa, W. B. Lasich, N. N. Raina, M. C. Amerighi, A. Bonetti, M. Di Corato, C. C. Dilworth, C. A. Fedrighini, E. Quercigh, A. E. Sichirolo, and G. Vegni. *Nuovo cimento* (10), 19: 1077-89 (Mar. 16, 1961). (In English)

A study is made of fast baryons emitted from 12,150 K^- meson interactions at rest in emulsion, in order to determine the nature and extent of K^- meson-multinucleon capture processes. Fast Σ hyperons are produced in at least 9% of all interactions; direct fast Λ^0 hyperon production is indicated by the presence of protons with energies exceeding 200 Mev. An upper limit of 30% is obtained for multinucleon processes (not producing π mesons) from consideration of π meson emission. The energy spectra for fast Σ hyperons and fast protons are given. Mass determinations on a sample of fast protons reveal about 10% deuterons and tritons. The apparent infrequency of the reaction $K^- + n \rightarrow \Sigma^- + n$ is confirmed and an α -particle model of the K^- meson-multinucleon interaction proposed to explain both this infrequency and the emission of deuterons and tritons. (auth)

18673 THE RELATIVISTIC INCREASE OF THE SPECIFIC PRIMARY IONIZATION IN HELIUM. C. Bal-lario, A. De Marco, R. D. Fortune, and C. Verkerk (CERN, Geneva). *Nuovo cimento* (10), 19: 1142-54 (Mar. 16, 1961). (In English)

The relativistic increase of the specific primary ionization produced by electrons in a helium-alcohol mixture is determined, from measurements of mean length made on photographs of post-expansion tracks in a Wilson cloud chamber. A logarithmic increase of the relative ionization as a function of p/mc is found from $p/mc \sim 5$ up to $p/mc \sim 300$, and there is some evidence of a density effect at $p/mc \sim 678$ where the primary ionization relative to the minimum is 1.50 ± 0.03 . The extent of the logarithmic increase and the ratio of the plateau to the minimum ionization are significantly greater than those calculated for pure helium. Measurements of the specific primary ionization by the technique of gap counting are shown to be uncorrelated with variations in the relative condensation efficiency (θ) in the range $0.2 \leq \theta \leq 0.6$. This enables precise measurements of ionization to be made which do not necessitate critical adjustments of expansion conditions in the cloud chamber. (auth)

18674 PROPERTIES OF NEUTRAL STRANGE PARTICLES PRODUCED IN A XENON BUBBLE CHAMBER. J. L. Brown, H. C. Bryant, R. A. Burnstein, D. A. Glaser, R. Hartung, J. A. Kadyk, J. D. Van Putten, D. Sinclair, G. H. Trilling, and J. C. Van der Velde (Univ. of Michigan, Ann Arbor). *Nuovo cimento* (10), 19: 1155-70 (Mar. 16, 1961). (In English)

By means of direct observations of the neutral decay modes $\Lambda \rightarrow n + \pi^0$ and $K_S^0 \rightarrow \pi^0 + \pi^0$ of Λ 's and K^0 's produced in a 21-liter liquid xenon bubble chamber exposed to 1.0 Bev and 1.1 Bev π^- beams, the branching ratios $B_\Lambda =$

$[(\Lambda \rightarrow \pi^0 + n)/(\Lambda \rightarrow \pi^0 + n) + (\Lambda \rightarrow \pi^- + p)] = 0.35 \pm 0.05$ and $B_K \equiv [(K_1^0 \rightarrow \pi^0 + \pi^0)/(K_1^0 \rightarrow \pi^0 + \pi^0) + (K_1^0 \rightarrow \pi^- + \pi^+)] = 0.30 \pm 0.035$ are found in agreement with predictions of the $|\Delta I| = \frac{1}{2}$ rule. The fraction of all K^0 's that do not decay into $\pi^+ + \pi^-$ or $\pi^0 + \pi^0$ in a time of the order of 10^{-10} sec is $X_K = 0.47 \pm 0.03$, as expected from the particle mixture description of the K^0 . Λ 's produced in xenon exhibit an "up-down" asymmetry associated with a polarization of the Λ normal to the production plane, although this polarization is not as great as that observed for Λ 's produced by similar beams in hydrogen. No significant forward-backward decay asymmetry of the Λ with respect to its own line of flight is found. Strange particle production cross-sections in xenon are reported. (auth)

18675 INTERACTIONS OF 1.15 GeV/c K^- -MESONS IN EMULSION. [PART] II. A. Marzari Chiesa, B. Quassiat, and G. Rinaudo (Istituto Nazionale di Fisica Nucleare, Turin). *Nuovo cimento* (10), 19: 1171-82 (Mar. 16, 1961). (In English)

Interactions of 1.15 BeV/c K^- mesons in emulsion are studied. The results concern the energy spectrum and angular distribution of the re-emitted K^- , the π -meson production, the mean lifetimes of Σ^+ , Σ^+ , and Σ^- hyperons, the nuclear scatterings of Σ^+ and the up-down asymmetry in the decay of the Σ^+ hyperon. (auth)

18676 ON THE μ -MESONIC ATOMS. Y. Eisenberg and D. Kessler (Weizmann Inst. of Science, Rehovoth). *Nuovo cimento* (10), 19: 1195-1210 (Mar. 16, 1961). (In English)

In an attempt to analyze the problem of the "missing x rays" in the capture of μ mesons by the light elements, a cascade calculation of the μ meson transitions in the mesonic atom is conducted. The results indicate that the calculated K x-ray yields for $Z \leq 6$ and the L x-ray yields for $Z \leq 14$ are above the experimental values. The deficiency of x-rays increases linearly with decreasing quantum energy between about 90 kev and 20 kev. The experimental yields agree with the calculations above 90 kev, and are lower than the calculated values, by a factor of about 5, at 20 kev. Good agreement between the calculations and experiment is obtained, however, for the (approximately energy-independent) ratios of the higher to basic x-ray yields, provided that a proper choice of the initial meson distribution is made. A comparison between the calculated Auger electron yields and the experimental results for μ^- -capture in nuclear emulsions indicates that "mixed" Auger-radiative transitions are effective (apparently close to 100%) in the de-excitation of the metastable 2s level in CNO. If these mixed transitions play the same role also in the lightest elements (Li, Be, B), the problem of the "missing" x-rays becomes more serious than before. The expected Auger electron spectrum for μ^- -capture in the heavy elements (AgBr) of nuclear emulsion is also calculated. (auth)

18677 FREQUENCY OF THE DECAY MODE $\Sigma^+ \rightarrow p + \gamma$. J. Schneps (Tufts Univ., Medford, Mass. and Università, Padua) and Y. W. Kang. *Nuovo cimento* (10), 19: 1218-20 (Mar. 16, 1961). (In English)

Events are searched for that can be attributed to the rare decay mode $\Sigma^+ \rightarrow p + \gamma$. These events in nuclear emulsion will give a proton of unique range 3045 μ m. Four events consistent with this interpretation are found in a sample containing 264 normal decays $\Sigma^+ \rightarrow p + \pi^0$. Taking into account background which could come from Σ^- one-prong stars or decays in flight of very slow Σ^+ in the normal way, the frequency of $\Sigma^+ \rightarrow p + \gamma$ is estimated to be about 1% that of $\Sigma^+ \rightarrow p + \pi^0$. (auth)

18678 PROPOSAL FOR THE DETERMINATION OF THE MESONIC MEAN SQUARE RADIUS OF NUCLEONS

FROM KNOCK ON PION PRODUCTION. G. Domokos (Central Research Inst. for Physics, Budapest). *Nuovo cimento* (10), 19: 1221-5 (Mar. 16, 1961). (In English)

A method is proposed to determine the mesonic mean square radius of nucleons from the differential cross-section of "knock-on" pion production. The essence of the method consists in extrapolating the differential cross-section, as a function of the nucleon recoil momentum, to unphysical values. The size of the unphysical region decreases with increasing primary energy. Possible limitations of the method are discussed. (auth)

18679 THE MEAN FREE PATH FOR α -PARTICLES IN NUCLEAR PHOTOGRAPHIC EMULSION. R. L. English (Washington Univ., St. Louis). *Nuovo cimento* (10), 19: 1269 (Mar. 16, 1961). (In English)

The mean free path (λ) in nuclear photographic emulsion is measured for α particles with energies on the order of 600 Mev/nucleon. A value of 19.2 ± 0.4 cm was obtained for λ . (T.F.H.)

18680 MEASUREMENTS ON THE π^- -He CROSS SECTIONS AT HIGH ENERGY. G. Brautti, L. Chersovani, C. Franzinetti, M. Sedmak-Furlan, and R. Tosi-Torelli (Università, Trieste and Istituto Nazionale di Fisica Nucleare, Trieste). *Nuovo cimento* (10), 19: 1270-4 (Mar. 16, 1961). (In English)

Results of π^- -He⁴ interaction studies at 0.97, 1.67, and 2.26 BeV are presented. The total cross sections, the elastic scattering cross sections, and the strange particle (Λ^0 and Σ^0) production cross sections are reported. The measurements are made in a liquid He⁴ bubble chamber; the 1.67 and 2.26 BeV measurements are made with an external field of 14.3 kgauss. (T.F.H.)

18681 THE COULOMB SCATTERING OF NEUTRAL HYPERONS AND THE LIFETIME OF THE Σ^0 . W. S. C. Williams (Univ. of Glasgow). *Nuovo cimento* (10), 19: 1278-9 (Mar. 16, 1961). (In English)

The hyperon decay ($\Sigma^0 \rightarrow \Lambda^0 + \gamma$) can be reversed by scattering Λ^0 hyperons in a nuclear electric field. The differential scattering for Σ^0 production is inversely proportional to the lifetime (τ) of the Σ^0 ; so that a Σ^0 production study might be used to bracket the lifetime. An experiment for finding τ is described in which 1 BeV/c Λ^0 hyperons strike a lead foil. (T.F.H.)

18682 RADIATION FROM FAST PARTICLES MOVING THROUGH MAGNETIC MATERIALS. T. B. Day (Univ. of Maryland, College Park). *Phys. Rev.*, 122: 1028-36 (May 15, 1961).

The problem of the generation of a changing magnetic field due to the interaction of a fast particle with a magnetic medium is studied. This combined Cherenkov-spin wave effect is shown to give rise to a "ringing" of the spin system under certain conditions of frequency and angle of observation, at least within an approximate evaluation of the general Green's function for the problem. Some differences from the usual Cherenkov effect are discussed and possibilities of using this effect as a neutral magnetic moment detector or as a probe of magnetic materials are mentioned. (auth)

18683 ALPHA-PARTICLE IONIZATION IN POLY-ATOMIC GASES AND THE ENERGY DEPENDENCE OF W. William P. Jesse (St. Procopius Coll., Lisle, Ill.). *Phys. Rev.*, 122: 1195-1202 (May 15, 1961).

A series of measurements by three different methods is carried out to determine the variation of W, the average energy to make an ion pair in the gases N₂ and C₂H₄ as a function of the energy of the ionizing alpha particle. In one method, the ionization ratios are determined in the two

gases for single alpha particles from two collimated polonium sources, the particles from one source being reduced in energy by passage through a succession of interchangeable mica windows. The corresponding energy ratios are determined by auxiliary measurements in pure argon, the W values in argon being assumed constant. W values for alphas of initial energy up to 9 Mev are also obtained by a comparison in C_2H_4 and N_2 of the relative ionization from single alpha particles from $(Po^{210} + U^{238})$ and $(Po^{210} + Po^{212})$ sources. These experiments indicate a continuous decrease in W values in C_2H_4 and N_2 with increasing alpha energy over a range from 1 to 9 Mev. The differential w (defined as the ratio of energy increment ΔE to ionization increment ΔI at any point on the alpha path) also decreases similarly and seems to approach but never quite reach, within the limits of alpha energy so far investigated, the corresponding W value for beta particles. No explanation of this continuous decrease with energy of the W values can at present be advanced. (auth)

18684 EMISSION OF PHOTONEUTRINOS AND PAIR ANNIHILATION NEUTRINOS FROM STARS. Hong-Yee Chiu (Inst. for Advanced Study, Princeton, N. J.) and Robert C. Stabler. *Phys. Rev.*, 122: 1317-22 (May 15, 1961).

Field-theoretic calculations of the cross sections for the photoneutrino process, $\gamma + e^- \rightarrow e^- + \nu + \bar{\nu}$, and the pair annihilation process, $e^+ + e^- \rightarrow \nu + \bar{\nu}$, are performed in order to obtain the neutrino luminosity of very hot stars ($T_c \approx 5 \times 10^8$ °K). The energy loss rate obtained for the latter process is sufficient to determine the rate of evolution of the stellar core when $T_c \approx 2 \times 10^9$ °K. (auth)

18685 POLARIZATION OF THE RECOIL PROTON FROM π^0 PHOTOPRODUCTION IN HYDROGEN. J. O. Maloy (California Inst. of Tech., Pasadena), G. A. Salandin, A. Manfredini, V. Z. Peterson, J. I. Friedman, and H. Kendall. *Phys. Rev.*, 122: 1338-40 (May 15, 1961).

The $D_{3/2}$ nature of the second resonance in neutral single pion photoproduction, $\gamma + p \rightarrow p + \pi^0$, is confirmed by observations of the polarization of the recoil proton over a range of photon energies. The photon energy dependence of the polarization at 90° c.m. is in substantial disagreement with alternative models. An experimental method using nuclear emulsion as scatterer-detector, in conjunction with a magnetic spectrometer, is shown to have both good energy resolution and reasonable counting rate. (auth)

18686 APPLICATION OF THE SCHWINGER VARIATIONAL METHOD TO ZERO-ENERGY ELECTRON-HYDROGEN SCATTERING. H. E. Saraph (University Coll., London). *Proc. Phys. Soc. (London)*, 77: 827-9 (Apr. 1, 1961).

The problem is formulated in terms of the radial exchange equations. The Schwinger method, with polynomial trial functions, is used to calculate the scattering length. Three-term polynomials yield $\Lambda^+ = -9.72$, $\Lambda^- = -2.35$, compared with $\Lambda^+ = -8.095$, $\Lambda^- = -2.350$ from exact numerical integrations. (auth)

18687 POLARIZATION OF 9 MeV PROTONS ELASTICALLY SCATTERED FROM C AND Al. D. Hoare, A. B. Robbins, and G. W. Greenlees (Birmingham Univ., Eng.). *Proc. Phys. Soc. (London)*, 77: 830-2 (Apr. 1, 1961).

The polarization of 9 Mev protons, elastically scattered from C and Al, is measured using a double scattering technique. The polarization is obtained from the left-right scattering asymmetry from He as recorded in photographic emulsions. Angular distributions from the polarization and elastic scattering cross section are compared with predic-

tions of optical model calculations. The general features of the scattering from Al are described by the optical model calculation, while the scattering from C appears to have strong contributions from sources other than the shape-elastic scattering. (auth)

18688 P-WAVE PION-PION RESONANCE. A. N. Kamal (Univ. of Liverpool). *Proc. Phys. Soc. (London)*, 77: 917-21 (Apr. 1, 1961).

A new phenomenological coupling constant in the pion-pion interaction is introduced through an interaction Lagrangian of the form $\mathcal{P}_{int} = \lambda_1 (\phi \times \phi, \mu) \cdot (\phi \times \phi, \mu)$. It is found that this type of interaction leads to a P-wave pion-pion resonance when summation is made over the "chain-diagrams." The width of the resonance is adjusted by a cut-off and λ_1 is determined by the position of the resonance and the cut-off. (auth)

18689 ABSOLUTE MEASUREMENT OF W FOR Po^{210} ALPHA PARTICLES IN AIR, NITROGEN, AND CARBON DIOXIDE. Z. Bay, P. A. Newman, and H. H. Seliger (National Bureau of Standards, Washington, D. C.). *Radiation Research*, 14: 551-65 (May 1961).

The average energy expended in producing an ion pair, W_α , was measured for air, carbon dioxide, and nitrogen in a twin-chamber system consisting of identical cylindrical chambers. The values obtained were 34.97 ± 0.07 for air, 36.38 ± 0.07 for nitrogen, and 34.04 ± 0.1 for carbon dioxide. The calculations were made on the basis of Po^{210} α energy of 5.3054 ± 0.001 Mev and electronic charge of 1.6020×10^{-19} coulomb. The reason for smaller values than those previously obtained is probably due to improved source preparation techniques, resulting in less self-absorption, and more careful extrapolation techniques in determining saturation currents. (N.W.R.)

18690 COMPARISON OF THE IONIZATION PRODUCED IN AIR BY ALPHA PARTICLES NEAR 5 MEV AND BY BETA PARTICLES. Z. Bay and P. A. Newman (National Bureau of Standards, Washington, D. C.). *Radiation Research*, 14: 566-72 (May 1961).

The differential W_α in air in the energy interval 4 to 5 Mev was determined and shown to be equal to W_β within experimental error. The results suggest that the differential quantity W_α begins to rise, while the energy diminishes, at some energy less than 4 Mev, accounting for W_α being larger than W_β . $W_\alpha = 34.97 \pm 0.07$ ev/ion pair for Po^{210} and $W_\beta = 33.7 \pm 0.3$ ev/ion pair for S^{85} . (N.W.R.)

18691 ON THE POLARIZATION AND QUADRUPOLE POLARIZATION OF DEUTERONS IN ELASTIC SCATTERING ON NUCLEI. A. G. Sitenko and V. K. Tartakovskii (Inst. of Physics and Technology, Khar'kov State Inst.). *Ukrain. Fiz. Zhur.*, 5: 581-90 (Sept.-Oct. 1960). (In Ukrainian)

The elastic scattering of deuterons on nuclei is considered in diffractive approximation. The amplitude of the elastic scattering of the deuteron is expressed by the scattering of a free neutron and proton on the nucleus. Allowance is made for the simultaneous scattering of a neutron and a proton and the applicability of impulse approximation is investigated. The vector and tensor polarizations of the deuteron are determined in the case of elastic scattering due to spin-orbital interaction of nucleons with the nucleus, as well as to the presence of D-waves in the ground state of the deuteron. (auth)

18692 A PARITY DOUBLET OF π -MESONS AND CHEW'S APPROXIMATION METHOD. Yu. M. Lomsdaze, V. I. Lendel, and B. M. Ernst (Uzhgorod State Univ., [Ukr., SSR]). *Ukrain. Fiz. Zhur.*, 5: 773-6 (Nov.-Dec. 1960). (In Ukrainian)

A fairly satisfactory agreement between theory and experiment in all forms of N-N scattering in an energy band of 100 to 600 Mev was obtained on the basis of the hypothesis that there exists a parity doublet of π mesons and employing a modification of the perturbation method in quantum field theory. The authors show that the field coupling constants satisfy the relationships obtained by Chew's approximation method. The possible disturbance of dispersion relations at superhigh energies (≥ 30 Bev) as well as possible disagreement in the values of the coupling constant obtained from dispersion relations and by Chew's method are discussed. (auth)

18693 ON THE PROBLEM OF THE RADIATIVE DECAY OF A π^- -MESON. I. Yu. Krivskii, Yu. M. Lomsadze, V. I. Fushchich, and I. V. Khimich (Uzhgorod State Univ., [Ukr., SSR]). *Ukrain. Fiz. Zhur.*, 5: 777-80 (Nov.-Dec. 1960). (In Ukrainian)

Renormalized invariance of quantum field theory based on the universal Fermi interaction was used for developing the finite expressions for the decay probability $\pi \rightarrow e + \nu + \gamma$ in the first nonvanishing approximation of perturbation theory. The relation of $\pi \rightarrow e + \nu + \gamma$ and $\pi \rightarrow \mu + \gamma$ decays is $\sim 3 \times 10^{-7}$, which is in good agreement with experiment. (R.V.J.)

18694 EMISSION IN VACUUM OF CHERENKOV RADIATION PRODUCED ON LONGITUDINAL WAVES IN A MEDIUM. B. L. Zhelnov (Inst. of Radiophysics and Electronics, Siberian Branch of the Academy of Sciences, USSR). *Zhur. Eksptl'. i Teoret. Fiz.*, 40: 170-7 (Jan. 1961). (In Russian)

Emission of light from an electron moving into vacuum from a medium with spatial dispersions is considered. The additional boundary conditions required in order to take into account space dispersion are discussed. It is shown that along with transition radiation emitted into vacuum, under certain conditions Cherenkov radiation produced in a medium on longitudinal waves may also be emitted. The angular distribution of this radiation for a weakly absorbing medium is defined by the refraction law together with the condition for Cherenkov radiation in the medium. The main contribution to the transition radiation is from Cherenkov radiation on longitudinal waves produced in a medium near the interface (over a distance of the order of a wave length). At large distances from the interface this part of the Cherenkov radiation is a spherical wave restricted to a narrow frequency range lying near the plasma frequency. (auth)

18695 AN ESTIMATION OF THE ROLE OF THE LAW OF CONSERVATION OF ANGULAR MOMENTUM IN THE STATISTICAL THEORY OF PARTICLE PRODUCTION. Ya. I. Granovskii and G. I. Kopylov (Inst. of Nuclear Physics, Academy of Sciences, Kazakh SSR). *Zhur. Eksptl'. i Teoret. Fiz.*, 40: 180-2 (Jan. 1961). (In Russian)

It is shown that if conservation of the z-component of the angular momentum during multiple meson production is taken into account by the simplest classical way, the predictions of the statistical theory remain almost unchanged. The anisotropy in the angular distribution of the particles which thus appears is apparently smaller than that observed in reality. (auth)

18696 ON THE EXACT SOLUTION OF THE BASIC CASCADE THEORY EQUATIONS. V. S. Synakh. *Zhur. Eksptl'. i Teoret. Fiz.*, 40: 194-8 (Jan. 1961). (In Russian)

Exact numerical solutions of the basic cascade theory equations are given which are obtained by the functional transformation method for small depths (up to two radiation lengths). (auth)

18697 INTEGRAL EQUATION FOR PION-NUCLEON SCATTERING AT LOW ENERGIES. Hung-yüan Chu (Joint Inst. for Nuclear Research, Dubna, USSR). *Zhur. Eksptl'. i Teoret. Fiz.*, 40: 227-36 (Jan. 1961). (In Russian)

A set of coupled integral equations for the S and P pion-nucleon scattering wave amplitudes at small energies is deduced on basis of the dispersion relations for forward and backward scattering and the unitarity condition. The contribution of the cut in the nonphysical region is taken into account without applying the analytic continuation by the Legendre expansion. The $\bar{N}N$ -annihilation amplitudes which are explicitly related to the $\pi\pi$ -interaction effect enter the integral equations. (auth)

18698 ON ELECTRON SCATTERING PROCESSES AT HIGH ENERGIES. S. S. Sannikov (Inst. of Physics and Tech., Academy of Sciences, Ukrainian, SSR). *Zhur. Eksptl'. i Teoret. Fiz.*, 40: 237-45 (Jan. 1961). (In Russian)

A technique is developed for the calculation of various scattering processes involving fast polarized electrons which can be described by two-component spinors. Peculiarities of the helical properties of electrons are elucidated. The cross section for pair production in electron-positron collisions is determined. (auth)

18699 COMMENT ON VARIATIONAL CALCULATIONS OF POLARIZABILITY. M. N. Adamov and V. A. Zubkov (Leningrad State Univ.). *Zhur. Eksptl'. i Teoret. Fiz.*, 40: 246-8 (Jan. 1961). (In Russian)

It is shown that in constructing the function for variational calculation of the electron polarizability in the excited state it is necessary to take into account the condition imposed by orthogonality of the perturbed wave functions. The excited state polarizabilities for an electron in a hydrogen atom or a one-dimensional infinitely deep potential well calculated by taking into account the aforementioned requirement agree satisfactorily with the exact values, approaching them from below. (auth)

18700 ISOTOPIC INVARIANCE IN PROCESSES INVOLVING ANTIHYPERONS. V. A. Lyul'ka. *Zhur. Eksptl'. i Teoret. Fiz.*, 40: 256-61 (Jan. 1961). (In Russian)

A number of relations between cross sections for reactions involving antihyperons is derived on basis of isotopic invariance hypothesis. Some additional relations between the cross sections arise if interaction of π^- and K-mesons with baryons predominates in states with definite isotopic spin values. (auth)

18701 APPLICATION OF SUPERCONDUCTIVITY THEORY METHODS TO THE PROBLEM OF THE MASSES OF ELEMENTARY PARTICLES. V. G. Vaks and A. I. Larkin. *Zhur. Eksptl'. i Teoret. Fiz.*, 40: 282-5 (Jan. 1961). (In Russian)

Superconductivity methods are applied to a Heisenberg type four-fermion two-component Lagrangian with cut-off. Due to rearrangement of the vacuum state the two-componentness of the initial field does not hinder the appearance of a fermion mass. Boson excitations are found which are similar to acoustic ones in superconductors. Interaction between the excitations is discussed. (auth)

18702 POLARIZATION EFFECTS IN THE SCATTERING OF μ MESONS ON PROTONS. G. V. Frolov (Radium Inst., Academy of Sciences, USSR). *Zhur. Eksptl'. i Teoret. Fiz.*, 40: 296-7 (Jan. 1961). (In Russian)

The polarization of recoil protons and scattered μ -mesons during the scattering of polarized μ -mesons on unpolarized protons is computed by taking into account the proton electromagnetic form factors. (auth)

18703 SOME SINGULARITIES OF THE SCATTERING AMPLITUDE IN PERTURBATION THEORY. A. Z. Patashinskii, A. P. Rudik, and V. V. Sudakov. Zhur. Eksptl'. i Teoret. Fiz., 40: 298-311 (Jan. 1961). (In Russian)

The asymptotic behavior of the position of the "open envelope" perturbation theory diagram singularities is studied for one of the invariants tending to infinity. It is shown that in the general case the "open envelope" has two singular curves. A method is developed for reducing the problem of determining the singularities of any perturbation theory diagram with four external lines to the problem of the "open envelope" diagram with certain effective masses of virtual particles. The effective mass minorants are determined. The results are applied in perturbation theory to analyze $\pi\pi$ -, KK- and NN-scattering in the case when one of the invariants characterizing the scattering amplitude tends to infinity. It is found that under these conditions the $\pi\pi$ -scattering amplitude does not possess any anomalous singularities in any perturbation theory approximation. Conditions are indicated which enable one in a number of cases to establish for KK- and NN-scattering amplitudes the absence of anomalous singularities in the perturbation theory diagram. (auth)

18704 SYMMETRIC COMPOSITE MODEL OF STRONGLY INTERACTING ELEMENTARY PARTICLES. Ya. B. Zel'dovich. Zhur. Eksptl'. i Teoret. Fiz., 40: 319-23 (Jan. 1961). (In Russian)

A scheme is considered in which all baryons (p, n, Λ , Σ , Ξ) consist of two particles and one antiparticle from a set of three elementary fermions A, B, C. It is shown that the best choice is that in which A and B are identical to Ξ^0 and Ξ^- with respect to charge and strangeness and C is identical to Λ . The masses of A, B, and C are assumed to be large so that the particles are unstable with respect to strong interactions and are therefore unobservable. In this scheme the parity of all observable baryons is the same and opposite to the parity of the elementary fermions A, B, and C. Pions and K-mesons are pseudoscalar with respect to the baryons. (auth)

18705 ON THE MANDELSTAM REPRESENTATION IN PERTURBATION THEORY FOR AN ANOMALOUS MASS RELATION. V. N. Gribov, M. V. Terent'ev, and K. A. Ter-Martirosyan. Zhur. Eksptl'. i Teoret. Fiz., 40: 337-40 (Jan. 1961). (In Russian)

The analytic properties of the square diagram in perturbation theory are investigated. With this diagram as a particular case it is demonstrated how the Mandelstam representation changes in the case of an anomalous relation between the particle masses. (auth)

18706 ANGULAR DISTRIBUTION ASYMMETRY OF μ -e DECAY ELECTRONS IN MAGNETIC FIELDS UP TO 35000 Oe. S. A. Ali-Zade, I. I. Gurevich, and B. A. Nikol'skii. Zhur. Eksptl'. i Teoret. Fiz., 40: 352-6 (Feb. 1961). (In Russian)

The asymmetry in the angular distribution of μ -e-decay electrons in magnetic fields was studied by observing π - μ -e-decays in photographic emulsions. It has been found that longitudinal magnetic fields up to 20,000 to 30,000 Oe do not completely remove the depolarizing action of the medium (emulsion) on the μ -meson. (auth)

18707 PRODUCTION OF Λ^0 (Σ^0)-HYPERONS AND K^0 -MESONS IN π^- p-INTERACTIONS AT 6.8 ± 0.6 Bev/c. Kang-chang Wang, Ts'u-tsiang Wang, V. I. Veksler, I. Vrana, Ta-ts'ao Ting, V. G. Ivanov, E. N. Kladnitskaya, A. A. Kuznetsov, Nguyen Dinh Tu, A. V. Nikitin, M. I. Solov'ev,

and Ling-yen Ch'eng (Joint Inst. for Nuclear Research, Dubna, USSR). Zhur. Eksptl'. i Teoret. Fiz., 40: 464-74 (Feb. 1961). (In Russian)

Processes involving the production of Λ^0 (Σ^0)-hyperons and K^0 -mesons in π^- p-collisions were studied for π^- -mesons of 6.8 Bev/c momentum. The cross section for production of Λ^0 (Σ^0)- and K^0 -particles, the ratio between the Y^0K^- and KK -pair production cross sections, the angular and momentum distributions of Λ^0 - and K^0 -particles in the c.m.s. and the transverse momentum distributions for Λ^0 - and K^0 -particles have been obtained. (auth)

18708 RECOIL EFFECT FOR THE TWO PARTICLE INTERACTION IN NONRELATIVISTIC QUANTUM FIELD THEORY. A. V. Tulub (Leningrad State Univ.). Zhur. Eksptl'. i Teoret. Fiz., 40: 488-90 (Feb. 1961). (In Russian)

The recoil effect for the two particle interaction energy is considered for the case of the scalar field theory. (auth)

18709 ON THE THREE-BODY PROBLEM IN THE CASE OF SHORT-RANGE FORCES. G. S. Danilov (Leningrad Inst. of Physics and Tech.). Zhur. Eksptl'. i Teoret. Fiz., 40: 498-507 (Feb. 1961). (In Russian)

It is shown that the amplitude for scattering of a particle on the bound state of two other particles can be expressed in terms of the two-particle problem and the energy of the bound state of the three particles. (auth)

18710 DETERMINATION OF THE PARITIES OF STRANGE PARTICLES WITH THE AID OF THE DISPERSION RELATIONS. Ya. I. Granovskii and V. N. Starikov (Inst. of Nuclear Physics, Academy of Sciences, Kazakh SSR). Zhur. Eksptl'. i Teoret. Fiz., 40: 537-45 (Feb. 1961). (In Russian)

The set of Matthews-Salam, Igi and Amati dispersion relations for scattering of K-mesons on protons are regarded as a (superdetermined) equation set with respect to the parities and coupling constants between a proton and a K-Y pair. The consistency condition leads to the result that the Λ^- and Σ^- -hyperon parities are opposite. The real part of the K^- -meson-proton scattering amplitude is positive and therefore attractive forces act in the K^- p system. (auth)

18711 THEORY OF INELASTIC SCATTERING OF NEUTRONS BY IMPERFECT CRYSTALS. M. A. Krivoglagz (Metallophysics Inst., Academy of Sciences, Ukrainian SSR). Zhur. Eksptl'. i Teoret. Fiz., 40: 567-84 (Feb. 1961). (In Russian)

Inelastic single phonon scattering of neutrons by solid solutions or crystals with imperfections is considered. Phonon scattering on static inhomogeneities in the crystal leads to broadening of the peaks in the energy distribution of coherently scattered neutrons. This broadening significantly depends on the order in arrangement of the solution atoms and becomes anomalously large near the critical points on the decomposition curve and phase transition points of the second kind. Peculiarities of broadening during scattering on vibrations corresponding to extremum points in the vibrations spectrum are considered. It is shown that account of distortions and correlations in the solution leads to the appearance of an angular dependence of the noncoherent scattering intensity, and imperfectness of the crystal leads to smearing out of the singularities in the energy spectrum of this scattering and in the distribution function of the vibration frequencies. Coherent scattering sharply increases near the critical point on the decomposition curve. Scattering of neutrons on local crystal vibrations is considered. (auth)

18712 HIGH ENERGY ELECTRON-ELECTRON SCATTERING. V. N. Baier and S. A. Kheifets. Zhur. Eksptl' i Teoret. Fiz., 40: 613-15(Feb. 1961). (In Russian)

The cross section for large angle scattering of high energy electrons by electrons is calculated in the double logarithmic approximation. (auth)

18713 CONTRIBUTION TO THE THEORY OF FERMION MASSES. Ya. B. Zel'dovich. Zhur. Eksptl' i Teoret. Fiz., 40: 637-40(Feb. 1961). (In Russian)

It is shown that four-fermion interaction of any order does not yield particle masses in a particle system with no bare masses. (auth)

18714 VARIATION OF THE ADIABATIC INVARIANT OF A PARTICLE IN MAGNETIC FIELD. [PART] II. A. M. Dykhne and A. V. Chaplik (Inst. of Radiophysics and Electronics, Siberian Section, Academy of Sciences, USSR). Zhur. Eksptl' i Teoret. Fiz., 40: 666-9(Feb. 1961). (In Russian)

The change in the adiabatic invariant during passage of a charged particle through a magnetic inhomogeneity is calculated by a previously developed method. The results significantly differ from those obtained with help of a model Hamiltonian. (auth)

18715 PHOTOPRODUCTION OF NEUTRINO-ANTINEUTRINO PAIRS ON ELECTRONS. Wang Yung, Ya. Fisher, I. Chulli, and S. Chulli (Joint Inst. for Nuclear Research, Dubna, USSR). Zhur. Eksptl' i Teoret. Fiz., 40: 676-7 (Feb. 1961). (In Russian)

The cross section for the process $\gamma + e^- \rightarrow \mu + \nu + \bar{\nu}$ is calculated in the extreme relativistic approximation. (auth)

18716 POSITION OF THE SINGULARITIES OF SOME FEYNMAN DIAGRAMS. V. A. Kolkunov. Zhur. Eksptl' i Teoret. Fiz., 40: 678-83(Feb. 1961). (In Russian)

The position of the singularity of diagrams describing the scattering of two particles is determined. (auth)

18717 TRANSVERSE POLARIZATION OF λ -HYPERONS GENERATED BY π^- -MESONS WITH A MOMENTUM OF 2.8 BeV/c IN XENON NUCLEI. I. A. Ivanovskaya, E. V. Kuznetsov, A. Prokesh, and I. V. Chuvilo (Joint Inst. for Nuclear Research, Dubna, USSR and Inst. for Theoretical and Experimental Physics, Academy of Sciences, USSR). Zhur. Eksptl' i Teoret. Fiz., 40: 708-9(Feb. 1961). (In Russian)

The up-down asymmetry in the decay of Λ hyperons generated by π^- mesons in a Xe bubble chamber by the reaction $\pi^- + \text{Xe} \rightarrow \Lambda + \text{Xe}' + n\pi$ was determined. Identification of the Λ particles and determination of the π^- and proton decay were carried out by measuring the scattering angle with respect to the p_Λ direction and by time-of-flight measurements. Results indicate that heavy nuclei cannot be used as target material for obtaining Λ particles under the experimental conditions used. (TTT)

18718 ON THE CALCULATION OF THE PARAMETERS OF THE UNELASTIC SCATTERING OF MEAN ENERGY ELECTRONS. A. N. Pilyankevich (Piljankevich) (Inst. of Metal Ceramics and Special Alloys, Academy of Sciences, USSR). Zhur. Tekh. Fiz., 31: 224-30(Feb. 1961). (In Russian)

Exchange interactions in inelastic electron scattering on isolated atoms result in reduced differential and total effective scattering cross sections. The degree of variation in cross sections, considering exchange in the incoherent scattering function, is determined by the magnitude of R_1^2 correction for the mean square radius of the scattering atom. This magnitude is related to the ns-n'p and np-n'd overlapping in single electron wave functions. (R.V.J.)

Neutron Physics

18719 (ARF-1164-12) RESEARCH STUDY ON NEUTRON INTERACTIONS IN MATTER AS RELATED TO IMAGE FORMATION. Technical Progress Report No. 3, January 1, 1961-March 31, 1961. H. V. Watts (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Apr. 10, 1961. Contract AT(11-1)-578. Project Agreement No. 2. 12p.

A review was made of the present state of the art of neutron detectors which appear usable for neutron imaging. The thermal or slow neutron energy region was investigated where cross section differences between elements are high, but where neutron scattering constitutes a major part of the total cross section in many elements. Using an optical spot diagram prepared from the analytically derived neutron scatter spread function for the thick scatterer, images were synthesized and compared to an equivalent neutron radiograph with some success. (B.O.G.)

18720 (NP-9965) IJ KING VAN EEN RADIUM-BERYLLIUM NEUTRONENBRON. (Thesis). (Absolute Yield of Radium-Beryllium Neutron Source). Jozias Johannes Vasmel (Amsterdam. Vrije Universiteit). July 1960. 77p.

The investigation was undertaken to obtain a neutron standard by measuring the absolute yield of a Ra-Be source containing 98.44 mg radium (as RaBr_2) mixed with 500 mg of beryllium. The neutrons from the source were slowed down to thermal energies in water and boric acid solutions and were detected with a small ionization chamber. It was necessary to discriminate against noise from the amplifiers and the pulses resulting from the γ -background of the source, and, to prevent piling up of the gammas, fast counting techniques were used. A calculation was made of the pulse spectrum of the ionization chamber. A description is given of the corrections which must be determined to find the total number of neutrons emitted by the source from the measurements of the neutron density in the medium. The source yield was determined as $946 \times 10^3 (\pm 2.2\%)$ neutrons per sec. (auth)

18721 CONSTRUCTION AND ABSOLUTE CALIBRATION OF A PHOTONEUTRON STANDARD. C. P. Galotto, (FIAT-LRCAA, Turin) T. Gerevini, F. Romanisio and F. Toselli. Energia nucleare (Milan), 8: 243-6(Apr. 1961). (In English)

A Ra- γ -Be photoneutron standard is developed consisting of a 4-cm diameter beryllium sphere carrying at its center 251.8 mg of radium. The calibration experiment is carried out by a physical integration method. The saturation activity is measured for 10% MnSO_4 aqueous solution irradiated in the absence and in the presence of a lattice of polyethylene tubes filled with gold powder, and the absolute average activity of gold is determined by coincidence measurements. The source strength is found to be $(3.11 \pm 0.07) \times 10^6$ neutrons/sec. (auth)

Nuclear Properties and Reactions

18722 (AFOSR-245) THE GREEN'S FUNCTION METHOD AND SUPERCONDUCTIVITY OF SYSTEMS OF FERMIONS. Jerzy Sawicki (California, Univ., Berkeley). [1960?] Contract AF 49(638)-327. 23p.

The method of Green's functions in the theory of many fermion systems has been recently developed by Gorkov and Migdal for the case of superconducting systems. Some further applications of their formalism are given both for zero and for finite temperatures. The pair distribution function of a superconducting system of fermions is cal-

culated by this method. The perturbation theory for impurities in superconductors described by one-particle operators is further discussed. The problem of residual two-body forces in a superconducting system is discussed. A reaction matrix-type treatment of such forces corresponding to a "ladder approximation" perturbation theory is indicated. (auth)

18723 (AFOSR-420) RESEARCH ON THE EXCITED STATES OF LIGHT ATOMIC NUCLEI. Serge Gorodetzky (Strasbourg, Université. Institut de Recherches Nucléaires). Jan. 15, 1961. Contract AF61(514)-1400. 13p.

Studies and experimental investigations of the states of light atomic nuclei, mainly with regard to spins, parities, and transitions between energy levels were conducted. The investigation was made by means of measurement of angular correlation of internal conversion electron pairs or mono-polar pairs. (auth)

18724 (ANL-6323) NEUTRON STRENGTH FUNCTIONS. BASED ON AN OPTICAL MODEL OF THE NUCLEUS CONSISTING OF A SPHERICAL COMPLEX POTENTIAL WELL WITH DIFFUSE SURFACE AND SPIN-ORBIT FORCE. P. A. Moldauer (Argonne National Lab., Ill.). Mar. 1961. Contract W-31-109-eng-38. 53p.

Results of computations are presented for the neutron strength functions (S_n) which refer to the orbital angular momentum (l), the laboratory energy of the neutrons (E_n) and the total angular momentum (J). (J.R.D.)

18725 (AWRE-O-28/60) NEUTRON CROSS-SECTIONS OF SELECTED ELEMENTS AND ISOTOPES FOR USE IN NEUTRONICS CALCULATIONS IN THE ENERGY RANGE 0.025 eV-15 MeV. B. R. S. Buckingham, K. Parker, and E. D. Pendlebury (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). Mar. 1961. 221p.

Neutron cross sections, angular probability distributions, and secondary neutron energy spectra for a number of elements and nuclides in the range from 0.025 eV to 15 MeV are summarized in graphical or tabular form. The data were compiled between early 1957 and April, 1960. Data are presented for H, d, t, He³, He⁴, Be⁹, B, C, N, O, F¹⁹, Na²³, Al²⁷, Si, Cl, Ca, Cr, Fe, Ni, Cd, Pb, Th²³², U²³³, U²³⁵, U²³⁸, Pu²³⁹, Pu²⁴⁰, and Pu²⁴¹. (M.C.G.)

18726 (CEA-1533) CONTRIBUTION A L'ÉTUDE DE L'ACTION DES CHAMPS ÉLECTROMAGNÉTIQUES SUR LES CORRÉLATIONS ANGULAIRES DES RAYONNEMENTS NUCLÉAIRES. (Contribution to the Study of the Action of Electromagnetic Fields on the Angular Correlations of Nuclear Radiation). Pierre Lehmann (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1960. 78p.

Thesis submitted to Univ. of Paris.

A study was made of interactions of electromagnetic fields with nuclear moments of nuclei emitting gamma rays. Experiments are described on delayed angular correlation showing the role played by statistic quadrupole interaction. Magnetic moments of the second excited state of F¹⁹ were measured using an external magnetic field. In the case of O¹⁶, experiments of angular distributions and angular correlations of gamma rays taking into account the possibility of perturbations, allow the determination of spins and parities of the three first levels. (auth)

18727 (CEA-1835) RÉSONANCE MAGNÉTIQUE NUCLÉAIRE DES NOYAUX DU FER 57 DANS LES CHAMPS LOCAUX DU GRENAT D'YTTRIUM ET DE FER. (Nuclear Magnetic Resonance of Iron-57 Nuclei in Local Fields in

Yttrium and Iron Garnets). Claude Robert (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1961. 3p.

The nuclear resonance of Fe⁵⁷ nuclei was demonstrated in the local field of each of the two magnetic sub-lattices of yttrium and iron garnets. The resonance frequencies and the relaxation times were measured as a function of the temperature. (auth)

18728 (CF-61-1-25) BREMSSTRAHLUNG ABSORPTION MEASUREMENTS FROM Sr⁹⁰TiO₃. T. A. Butler and E. E. Pierce (Oak Ridge National Lab., Tenn.). Jan. 13, 1961. 8p.

The absorption in lead of bremsstrahlung radiation from a Sr⁹⁰TiO₃ pellet in the proximity of Hastelloy "C" was measured. The tenth value layer of the more energetic components of the x-ray continuum was determined to be 1.60 inches. (auth)

18729 (JINR-D-625) AN ESTIMATION OF THE UPPER LIMIT OF THE CHARGE EXCHANGE CROSS SECTION IN (p-n) INTERACTION AT 8.5 BeV. V. A. Nikitin and E. N. Tzyganov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1961. 7p.

The upper limit of the cross section for elastic charge exchange p-n scattering was found to be $\sigma_{ex} \leq 0.46 \pm 0.15$ mb at 8.5 BeV using emulsions. According to the statistical theory, the cross section must be small at high energies: $\sigma_{ex} \approx 2 \times 10^{-4} \sigma_{in}$ at an energy of 10 BeV, where σ_{in} is the cross section for all inelastic processes. If elastic N-N scattering is due to the one-meson interaction, the σ_{ex}/σ_{el} ratio is equal to 4, where σ_{el} is the elastic scattering cross section. (D.L.C.)

18730 (LA-1939(Del.)) INELASTIC CROSS SECTIONS AND $\bar{\nu}$ FOR SOME FISSIONABLE ISOTOPES. H. A. Bethe, J. R. Beyster, and R. E. Carter (Los Alamos Scientific Lab., N. Mex.). Aug. 1955. Decl. with deletions May 5, 1960. 33p.

The transmissions of neutrons through spherical shells of normal uranium, or alloy, and Pu²³⁹ are reported. One group of measurements was made using a pure-fission neutron source produced by thermal neutrons in U²³⁵, and the following detectors: U²³⁵, U²³⁸, Np²³⁷ fissions, and an Al²⁷(n,p)Mg²⁷ activation detector. The other group of measurements was made using monoenergetic neutrons from a Van de Graaff and principally a neutron-sensitive scintillation counter with a variable threshold. A U²³⁵ spiral fission counter was used with the latter source to obtain information about $\bar{\nu}$, average number of neutrons per fission, for different energies of the fission-inducing neutrons. From both groups of measurements, the inelastic scattering cross sections were determined. The non-elastic cross sections for the uranium and plutonium isotopes are given for various neutron energies, and values of $\bar{\nu}$, averaged over the fission spectrum, are given. (auth)

18731 (NDA-2133-4) FAST NEUTRON CROSS SECTIONS OF MANGANESE, CALCIUM, SULFUR, AND SODIUM. Final Report Covering the Period December 1, 1959-December 31, 1960. E. S. Troubetzkoy, M. H. Kalos, H. Lustig, J. H. Ray, and B. H. Trupin (Nuclear Development Corp. of America, White Plains, N. Y.). Jan. 31, 1961. Contract DA-18-108-405-CML-295. 73p. (NDL-TR-5)

A set of neutron cross sections for manganese, calcium, sulfur, and sodium was prepared for energies up to 18 MeV. The cross sections tabulated include σ_T , σ_{nn} , $\sigma_{nn'}$, σ_{nx} , σ_{ny} , σ_{np} , σ_{na} , $\sigma_{n,2n}$, $\sigma_n(\theta)$, $\sigma_{nn}(E, E')$, and $\sigma_{nx\gamma}(E, E_\gamma)$. (auth)

18732 (NP-10070) RADIOCHEMICAL STUDIES OF DECAY PROPERTIES OF RADIOACTIVE NUCLEI. Interim Progress Report. R. W. Fink (Arkansas. Univ., Fayetteville). Mar. 15, 1961. 57p.

Although numerous results for the L/K-capture ratio are reported, there are only a very few cases in which the precision of the results are such that they may be compared critically with theory. This situation results from the difficulty of making corrections for the escape of K x rays from the counter. For low and medium weight elements a further difficulty exists in that the L x rays, which are of low energy, are absorbed before they reach the sensitive volume of the counter. To overcome these problems, a multiwire counter with internal anticoincidence was constructed in which the source could be introduced directly into the counter as a gas. In this system the correction for escape is reduced to a few percent. The availability of the ferrocene type compounds, which have an appreciable vapor pressure, made the possibility of L/K-capture ratio measurements on Fe⁵⁵ and Co⁵⁸ especially attractive. For Fe⁵⁵, the ratio, $P_L/P_K = 0.106 \pm 0.005$, and for Co⁵⁸, $P_L/P_K = 0.108 \pm 0.004$. When compared with theory (Brysk & Rose), the values agree within 10 and 20%, respectively, the experimental values being slightly larger than the theoretical predictions. The discrepancy is discussed in the light of the correction of Odier and Daudel, but it remains largely unexplained. (auth)

18733 (PAN-189/VII) ON THE OPTICAL MODEL FOR THE NUCLEON-NUCLEUS SCATTERING. (Model Optyczny dla Rozpraszania Nukleon-Jadro). J. Dabrowski and A. Sobieczewski (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw and Warsaw. Univ.) Nov. 1960. 22p.

The real and imaginary parts of the medium and high-energy optical potential for nucleon-nucleus scattering were calculated for an infinite nuclear medium with the help of recent phenomenological nucleon-nucleon phase shifts. For the S wave contribution, the exact solution of the equation for the nucleon-nucleon scattering in the nuclear medium for the separable nucleon-nucleon interaction was used. In the calculation of the $l > 0$ contribution to the imaginary part of the optical potential, the Goldberger method was applied. The results are compared with experiment and discussed. (auth)

18734 (PAN-194/I-A) AZIMUTHAL ANGULAR DISTRIBUTION OF α -PARTICLES FROM THE $^{10}\text{B}(n,\alpha)^7\text{Li}$ REACTION WITH POLARIZED THERMAL NEUTRONS. (Azymutalny Rozkład Katowy Cząstek α Z Reakcji $^{10}\text{B}(n,\alpha)^7\text{Li}$ ze Spolaryzowanymi Neutronami Termicznymi). K. Maluszynska, L. Natanson, and Yuan-Han-yong (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Nov. 1960. 7p.

The azimuthal angular distribution of α particles from the $\text{B}^{10}(n,\alpha)\text{Li}^7$ reaction with polarized thermal neutrons was measured and found to be isotropic, in agreement with theory. (D.L.C.)

18735 (TID-11929) ABSOLUTE $(n,2n)$, $(n,p\gamma)$, AND $(n,\alpha\gamma)$ CROSS SECTIONS FOR 14.1-MEV NEUTRONS ON ZIRCONIUM AND THE CALIBRATION OF A CRYSTAL SCINTILLATION SPECTROMETER. Clyde Howard Reed (Los Alamos Scientific Lab., N. Mex.). Feb. 1960. 245p.

Thesis submitted to Univ. of Utah.

Absolute $(n,2n)$, $(n,p\gamma)$, and $(n,\alpha\gamma)$ cross sections were measured for 14.1-Mev neutrons incident on natural zirconium for the following reactions: $\text{Zr}^{90}(n,2n)\text{Zr}^{89m}$ and $\text{Zr}^{90}(n,2n)\text{Zr}^{89}$; $\text{Zr}^{90}(n,p)\text{Y}^{90}$, $\text{Zr}^{91}(n,p)\text{Y}^{91m}$, $\text{Zr}^{91}(n,p)\text{Y}^{91}$, $\text{Zr}^{92}(n,p)\text{Y}^{92}$, and $\text{Zr}^{94}(n,p)\text{Y}^{94}$; and $\text{Zr}^{90}(n,\alpha)\text{Sr}^{87m}$, $\text{Zr}^{92}(n,\alpha)\text{Sr}^{88}$,

and $\text{Zr}^{94}(n,\alpha)\text{Sr}^{91}$. In addition, upper-limit values were obtained for the cross sections of the reactions $\text{Zr}^{86}(n,\alpha)\text{Sr}^{83}$, $\text{Zr}^{94}(n,pn)\text{Y}^{93}$, and $\text{Zr}^{94}(n,d)\text{Y}^{93}$. Neutron-induced activities of each irradiated zirconium sample were isolated by means of standard radiochemical procedures as separate zirconium, yttrium, and strontium fractions. Product nuclide activities were determined by the absolute counting of emitted beta and gamma radiation. The calibration was outlined of a NaI(Tl)-crystal scintillation spectrometer used to detect decay gamma radiation. Beta-gamma coincidence techniques were employed to standardize solutions of radioisotopes used in the crystal calibration procedure. (auth)

18736 (TID-12613) MASS AND CHARGE DISTRIBUTION FROM THE FISSION OF URANIUM ISOTOPES INDUCED BY INTERMEDIATE ENERGY HELIUM IONS (thesis). L. James Colby, Jr. (Purdue Univ., Lafayette, Ind.). June 1960. Contract AT(11-1)-347. 204p.

Fission cross sections were determined for 39.9- and 33.8-Mev helium ions on U^{238} and 40.5-, 34-5, 29.0-, and 25.3-Mev helium ions on U^{235} . The mass distribution results show that: (1) The mass yield curves for U^{235} excited by 20 to 40 Mev helium ions show a pronounced middle peak (triple hump) in the symmetric mode of fission. (2) The total reaction cross section data are in good agreement with alpha elastic scattering data and the radius of 1.41×10^{-13} cm is confirmed when the interaction radius of 2.19×10^{-13} cm for the alpha particle is used. (3) The radius parameter for the various uranium isotopes is constant. (4) The average number of total neutrons emitted per fission for a given excitation energy is less than previously reported. The charge distribution results show that: (1) The primary yield results are best correlated by the Constant-Charge-Ratio rule for 20- to 40-Mev helium ions on uranium isotopes. (2) There is evidence of a 82-neutron shell effect on the primary yields which possibly could lead to a perturbed charge distribution when these cross closed shells. (3) The shape of an unperturbed charge distribution curve is symmetric about a most probable charge and is nearly gaussian. A new method for accurately counting I^{130} in the presence of high activities of other iodine isotopes was developed. (D.L.C.)

18737 (TID-12629) ISOMERISM IN BROMINE NUCLEI (thesis). Albert Goodman (Los Alamos Scientific Lab., N. Mex.). 1960. 80p.

Submitted to the Univ. of New Mexico.

A search was made for isomerism in bromine nuclei using the pulsed-beam method. The procedure consisted of pulsing the beam of a Van de Graaff accelerator and counting any resulting activities during the time between pulses. After preliminary surveys during which natural bromine was bombarded with neutrons and natural selenium was bombarded with protons and deuterons, protons were used to bombard selenium targets enriched in selected isotopes. The spectra of the resulting activities were observed with a 100-channel analyzer and the half-lives were measured with a 9-channel time-delay analyzer. It was concluded from these measurements that there are isomers in Br^{77} , Br^{78} , and Br^{81} , as well as Br^{78} . Some of the activities found were previously reported but not assigned to any particular bromine isotope. It was possible to determine the transition type of each isomer and to deduce from this the characteristics of the first few energy levels of each of the nuclei studied. Properties of the ground state decay of Br^{78} were studied. (auth)

18738 (TID-12742) EXPERIMENTAL DIFFERENTIAL NEUTRON ELASTIC SCATTERING CROSS SECTIONS ANGULAR DISTRIBUTIONS (.13-20 MEV). H. A. Gerardo

(General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Feb. 28, 1961. Contracts AF 33(600)-38062 and AF(11-1)-171. 68p. (XDC-61-3-131)

Experimental differential neutron elastic scattering cross sections were compiled for the energy range from 0.13 to 20 Mev for sixteen natural elements pertinent to aircraft shielding calculations. Data are also included for U^{235} . The data were taken from BNL-400 and other published and unpublished sources. The absolute differential cross sections, in barns per steradian, are plotted against the cosine of the scattering angle; and the data are in the center-of-mass system unless noted otherwise. (auth)

18739 (UCRL-8982) DIRECT NUCLEON-NUCLEON COLLISIONS INSIDE THE NUCLEUS ACCORDING TO THE IMPULSE APPROXIMATION. Thomas P. Clements and Lester Winsberg (California. Univ., Berkeley. Lawrence Radiation Lab.). Aug. 11, 1960. 48p. Contract W-7405-eng-48.

Direct N-N collisions play an important role in high-energy nuclear reactions. The importance of such collisions at lower energies is not clear. To aid in the interpretation of nuclear reactions, analyses were made of the collisions between an incident nucleon and nucleons in a Fermi gas by the impulse approximation. The treatment is based on information from N-N scattering experiments. Collisions inside a nucleus are considered the same as those in the unbound state at the same center-of-mass energy, except for the effect of the Pauli exclusion principle. The effective elastic and inelastic cross section, (σ), between like and unlike nucleons is computed for incident energies from 10 Mev to 6 Bev at several values of the Fermi energy. The properties of the struck nucleons in allowed collisions are calculated. This information may prove useful in interpreting some recoil experiments. Analytical expressions for (σ) and quantities related to the struck nucleon are given for elastic collisions in which the scattering is isotropic and the free-particle cross sections are either constant or vary inversely as the bombarding energy. (auth)

18740 (WAPD-BT-22(p.19-30)) EFFECTIVE NEUTRON CAPTURE GAMMA RAY SPECTRA. K. Shure and G. L. Strobel (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

The fairly complex energy distribution of the gamma rays arising from the capture of neutrons in several materials was reduced to simple spectra consisting of two (and in one case, three) energy groups. These results will significantly reduce the computational effort entailed over that required for the more complex spectral descriptions while retaining the adequacy of the information generated. These spectra are sufficiently accurate to be applied in practical problems for the prediction of biological dose rates and of heat generation rates in structural materials. (auth)

18741 (AEC-tr-4561) COLLISIONS OF SLOW ELECTRONS WITH HYDROGEN ATOMS. V. I. Ochkur. Translated by Lydia Venters from Vestnik Leningrad Univ., 13: No. 4, Ser. Fiz. i Khim. No. 1, 53-68(1958). 19p.

The excitation of hydrogen atoms by slow electrons is considered. The equations describing the excitation are obtained from the variational principle and are solved numerically for the excitations to 2s, 2p, 3s, 3p, 3d, 4s, and 4f states for the energy range from 13.5 to 65 ev. The results show that for this energy range the shape of the excitation function may differ appreciably from the usual one. This must be attributed to the influence of exchange terms taken into account in the equations. S-phases for the elastic scattering on the atom in the ground state and the

excited states were calculated. It is shown that for the calculation of the elastic scattering, the higher the excitation of the state considered the smaller is the role of the exchange terms. (auth)

18742 (AEC-tr-4598) LIGHT IODINE ISOTOPES. N. G. Zaitseva, M. Ya. Kuznetsova, I. Yu. Levenberg, and V. A. Khalkin. Translated by Al Monks from Radiokhimiya, 2: 451-7(1960).

This paper was previously abstracted from the original language and appears in *NSA*, Vol. 15, abstract no. 3490.

18743 (CEA-tr-R-1075) SECTION EFFICACE DE LA REACTION $Be^9(n,\alpha)He^6$. (Cross Section for the Reaction $Be^9(n,\alpha)He^6$). S. S. Vassiliev, V. V. Komarov, and A. M. Popov. Translated by B. Vinogradoff into French from Atomnaya Energ., Suppl. No. 5, 92-3(1957). 3p.

The cross section for the reaction $Be^9(n,\alpha)He^6$ was measured for neutron energies from 1.0 ± 0.5 to 7.0 ± 0.5 Mev by the use of photographic plates containing spectrally pure Be powder. The results are tabulated. (J.S.R.)

18744 (CEA-tr-R-1216) PRODUCTION DU RADIO-ISOTOPE BÉRYLLIUM-7 DANS UN RÉACTEUR NUCLÉAIRE SUIVANT UNE RÉACTION NUCLÉAIRE SECONDAIRE. (Production of the Radioisotope Beryllium-7 in a Nuclear Reactor Following a Secondary Nuclear Reaction). N. P. Rudenko and A. I. Sevastianov. Translated into French from Radiokhimiya, 1: 691-3(1959). 7p.

The reaction $Li^6(t,2n)Be^7$ was detected. The formation of Be^7 in a nuclear reactor by a secondary reaction [$Li^6(n,\alpha)t$ and $Li^6(t,2n)Be^7$] was proved. The total production cross section was determined. The possibility of the simultaneous obtention of radioisotopes of Be and F by reactor irradiation of Li_2CO_3 was indicated. (tr-auth)

18745 (TT-936) SHELL MODEL COUPLING AND ANGULAR DISTRIBUTION OF THE REACTION $C^{13}(p\gamma)N^{14}$. O. Hittmair. Translated by D. A. Sinclair from Z. Naturforsch., 11a: 94-5(1956). 5p.

A discussion is given concerning the applicability of shell model coupling to the nuclear levels involved in determining the angular distributions for nuclear reactions. Using Rosenfeld's saturation potential for the central interaction, H_1 , the usual spin-path interaction, H_2 , and a value of 4.4 for the intercoupling parameter, ζ , the first three levels were obtained for N^{14} in agreement with the shell model. The LS wave functions which correspond to the levels and the fundamental state of C^{13} ($\zeta = 5$) are tabulated. (B.O.G.)

18746 (TT-942) REDUCED STRIPPING WIDTH AND SHELL MODEL. O. Hittmair. Translated by D. A. Sinclair from Acta Phys. Austriaca, 11: 70-4(1957). 8p.

The relations of reduced stripping widths to the shell model are summarized. Shell model paths and kinds of coupling give incisive information regarding reduced widths in stripping angular distributions, polarization, and angular correlations. (auth)

18747 (UCRL-Trans-648) THE THEORY OF GROUPS AND THE RADIOACTIVE DISTRIBUTIONS. Jean Thibaud. Translated from p.369-84 of "Louis de Broglie, Physicien et Penseur." (A publication of Editions Albin Michel, Paris, 1952). 27p. (Includes original, 17p.).

A discussion is given of the study of α emissions from polonium in group theory. The tests to which the experimental data were submitted were: a study of the length of unclassified intervals, or linear distribution; and a study of the lengths of classified intervals, i.e., left in their natural order of succession. It is concluded that the importance of the concepts of coherence and phase in the results are equally essential in wave mechanics. (B.O.G.)

18748 SOME FEATURES OF THE DECAY OF Au^{198} TO Pt^{198} . Olov Bergman. *Arkiv Fysik*, 18: 569-73(1961). (In English)

The conversion and gamma spectra were investigated with high energy resolution. The third excited state at 1091.3 ± 0.3 keV is assigned spin parity 1^- , and the total disintegration energy is estimated as 1110_{-11}^{+24} keV. (auth)

18749 PHOTONEUTRON REACTIONS IN C^{12} AND O^{16} . J. P. Roalsvig, Ishwar C. Gupta, and R. N. H. Haslam (Univ. of Saskatchewan, Saskatoon). *Can. J. Phys.*, 39: 643-56 (May 1961).

Absolute yields of the reactions $\text{C}^{12}(\gamma, n)\text{C}^{11}$ and $\text{O}^{16}(\gamma, n)\text{O}^{15}$ are determined at 22 MeV maximum bremsstrahlung energy. For the reaction $\text{C}^{12}(\gamma, n)\text{C}^{11}$ a yield curve from threshold to 24 MeV is obtained, and the cross section curve for the reaction is computed. (auth)

18750 HALF LIFE, Q_β VALUE, AND γ -RAY SPECTRUM OF La^{143} . K. Fritze, T. J. Kennett, and W. V. Prestwich (McMaster Univ., Hamilton, Ont.). *Can. J. Phys.*, 39: 662-7(May 1961).

The decay of La^{143} is investigated. A half life of 14.0 ± 0.1 min and a β decay Q value of 3.3 ± 0.1 MeV are found. The γ radiation is weak and the spectrum is rather complex. (auth)

18751 THE K INTERNAL CONVERSION COEFFICIENT OF THE 412-KEV TRANSITION IN Hg^{198} . J. L. Wolfson (National Research Council, Ottawa). *Can. J. Phys.*, 39: 773-7(May 1961). (NRC-6256)

An experiment is described in which the K internal conversion coefficient α_K for Hg^{198} is compared with α_K of Ni^{60} . The ratios of α_K for the 412 keV transition in Hg^{198} to each of the values of α_K for the 1.33 and 1.17 MeV transitions in Ni^{60} are measured. It is found that the measured ratios are higher than those predicted by theory. (T.F.H.)

18752 THE CONVERSION ELECTRON SPECTRUM FROM A MASS-SEPARATED SOURCE OF Xe^{133} . F. Brown, R. L. Graham, G. T. Ewan, and J. Uhler (Atomic Energy of Canada Ltd., Chalk River, Ont.). *Can. J. Phys.*, 39: 779-80(May 1961). (AECL-1229)

The conversion electron spectrum of the 80.99 keV γ decay of excited Cs^{133} is given. Cesium-133 is produced in the β^- decay of Xe^{133} ; the Xe^{133} is separated from Xe isotopes by mass spectrometry. The K, L, M, N, and O relative line intensities are shown. The M1/E2 ratio is examined. (T.F.H.)

18753 A NEW ISOTOPE Ir^{183} . A. K. Lavrukina, T. V. Malysheva, and B. A. Khotin (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Academy of Sciences, USSR). *Doklady Akad. Nauk S.S.S.R.*, 137: 551-2(Mar. 21, 1961). (In Russian)

A radioactively pure iridium fraction was separated from the spallation products of a sample of gold (0.5 g) that had been irradiated with 660-MeV protons for 0.5 to 1 hours in a cyclotron. Then, at various intervals of time (the time of accumulation of the daughter osmium activities was varied from 1.5 to 4.0 hrs), the osmium daughter activity was separated systematically from the iridium activity by distilling OsO_4 from a perchloric acid solution. The decay of the osmium activity was followed on an end-window counter. A half-life of 1 ± 0.1 hr was assigned to Os^{183} because of the variation in the amount of Os^{183} observed as a function of the time of separation of the osmium fraction. (TTT)

18754 THE STRUCTURE OF LIGHT NUCLEI. V. V. Balashov, V. G. Neudachin and Yu. F. Smirnov (Moscow State Univ.). *Izvest. Akad. Nauk S.S.S.R., Ser. Fiz.*, 25: 170-88(Feb. 1961). (In Russian)

The use of the shell model for calculating ground and lower excitation states and problems in the various models for light nuclei are reviewed and analyzed. The construction of wave functions in shell theory and applications of the shell model in estimating nuclear energy spectra, electromagnetic moments, and transitions in light nuclei are discussed. 45 references. (R.V.J.)

18755 THE SHAPE OF Ar^{41} BETA SPECTRUM. G. R. Kartashov, N. A. Burgov, and A. V. Davydov (Inst. of Theoretical and Experimental Physics, Academy of Sciences, USSR). *Izvest. Akad. Nauk S.S.S.R., Ser. Fiz.*, 25: 189-93 (Feb. 1961). (In Russian)

The shape of the Ar^{41} spectrum in forbidden first order β transitions is analyzed considering the compensation resulting from the universal theory of weak interactions. The scheme of Ar^{41} decay is given. In addition to the transition to K^{41} excited states, the transition to the ground state of the nucleus is also analyzed. (R.V.J.)

18756 CONVERSION ELECTRON SPECTRA OF HOLMIUM FRACTION IN $\text{Ta} + p$ REACTION. A. S. Basina, K. Ya. Gromov, G. S. Dzhelapov, and V. A. Morozov. *Izvest. Akad. Nauk S.S.S.R., Ser. Fiz.*, 25: 194-8 (Feb. 1961). (In Russian)

A β spectrometer with resolving power $\sim 1.9\%$ was used in investigating the conversion electron spectrum (30 to 1000 keV) of holmium prepared by Ta proton spallation. Conversion electron lines of half life ~ 30 min, ~ 1 hour, ~ 2.5 hours, ~ 5 hours, ~ 10 hours, and several days were observed. Data on the energy, half life, and relative intensities of conversion lines for Ho^{166} ($T_{1/2} = 55.5 \pm 5$ min) are tabulated. In addition to previously known transitions, transitions at 366 and 686 keV were found. Data on the relative intensities of K 138, K 268, and K 366 are in agreement with an assumption of E-2 type and identical intensities. The 686 keV transition was not completely identified, however, the half life of the transition relates it to Ho^{166} . The spectrum of conversion electrons for Ho^{168} ($T_{1/2} = 30 \pm 5$ min) was analyzed and eight transitions are tabulated. Among them are conversion electrons of the well known γ transitions at 98.6, 218.7, and 366 keV; the 320 keV line was not found. Conversion lines not related to the Ho^{161} or Ho^{168} decay are also tabulated. Among them only $E_1 = 201.8$ keV was strong enough to be identified; the half life 34 ± 4 min was assigned. The decay

scheme $\text{Ho}^{155} \xrightarrow[1.c]{46 \text{ min}} \text{Dy}^{155} \xrightarrow[1.c]{10 \text{ hours}} \text{Th}^{155} \xrightarrow[1.c]{5.6 \text{ days}}$

Gd^{155} is proposed. An attempt to determine the Ho^{155} half life by the k 227 line of the daughter Dy^{155} was not successful. (R.V.J.)

18757 RELATIVE INTENSITIES OF CERTAIN LINES IN Ta^{182} SPECTRUM. V. D. Vitman, N. A. Voinova, B. S. Dzhelapov, and A. A. Karan (Mendeleev All-Union Research Inst. of Metrology and Inst. of Physics and Technology, Academy of Sciences, USSR). *Izvest. Akad. Nauk S.S.S.R., Ser. Fiz.*, 25: 199-200(Feb. 1961). (In Russian)

A specially constructed magnetic spectrometer was used in investigating $\text{Ta}^{182}\gamma$ emission at 850 to 910 and 975 to 1280 keV in order to verify the relative γ intensities. The data are tabulated and correlated with the published data. The relative intensity of the 1045.9 keV line was determined. (R.V.J.)

18758 RELATIVE INTENSITIES OF $\text{RaC} \gamma$ RAYS AT 1300 TO 2520 KEV. V. D. Vitman, B. S. Dzhelapov, and A. A. Karan (Mendeleev All-Union Research Inst. of Metrology [USSR]). *Izvest. Akad. Nauk S.S.S.R., Ser. Fiz.*, 25: 201-6(Feb. 1961). (In Russian)

New data on $\text{RaC} \gamma$ intensities were developed with an

improved high-resolving-power spectrometer. A specimen of RaBr_2 was used as the source; the background was 0.04 coincidences per minute at $h\nu = 1350$ kev and less than 0.01 coincidences per minute at $h\nu = 1500$ kev. The spectrum exhibits a 2017 kev line in addition to the previously identified 2117, 2204, 2292, and 2445 kev lines. An excess of recoil electrons with relative intensity $\sim 1\%$ from the 2204 kev line was found in the region $h\nu = 2270$ kev. In the region 1700 to 2000 kev, the 1728 kev line separates from the 1764 kev line enabling a more precise evaluation of its intensity. The 1541 kev line was separated from the 1509 kev line. The 1583 kev line is twice as wide as the standard; explained by a new line at 1597 ± 4 kev. The relative intensities of the lines are tabulated. An attempt to find the 2513 kev line indicated that should such line exist its half life is less than 5×10^{-6} quanta per decay. (R.V.J.)

18759 GAMMA EMISSION OF Eu^{146} . E. E. Berlovich, V. N. Klement'ev, L. V. Krasnov, and M. K. Nikitin. (Ioffe Inst. of Physics and Tech., Academy of Sciences, USSR). *Izvest. Akad. Nauk S.S.S.R., Ser. Fiz.* 25: 207-11 (Feb. 1961). (In Russian)

Gamma emission in Eu^{146} electron capture was studied with a scintillation coincidence spectrometer. The resolving time varied from 0.2 to 20 μsec . The Gd fraction was separated from a Ta target bombarded by 660-Mev protons and used as the source. The main activity was related to Gd^{146} (60 days) and daughter Eu^{146} (5 days). The contribution of Gd^{146} to the Eu^{146} line was negligible. The relative intensities of transitions in Eu^{146} are tabulated and the γ and coincidence spectra are plotted. Neither the single spectra nor the coincidence spectra exhibited any direct transition from 1.38 Mev with intensity exceeding 0.05 of the 0.74 Mev line (taken as a unit). A decay scheme which agrees with the results is offered. The energy of Eu^{146} transition to Sm^{146} is 3350 kev according to Cameron and 3700 kev according to Levy, supporting the existence of levels up to 3.5 Mev. Observed γ quanta of 280 kev, which coincide with 115 to 120 kev quanta, belong to Cd^{146} and Eu^{147} . (R.V.J.)

18760 INVESTIGATION OF ENERGY LEVELS OF Eu^{147} , Eu^{149} , AND Eu^{151} . E. Berlovich, V. N. Klement'ev, L. V. Krasnov, and M. K. Nikitin (Ioffe Inst. of Physics and Tech., Academy of Sciences, USSR). *Izvest. Akad. Nauk S.S.S.R., Ser. Fiz.*, 25: 212-17 (Feb. 1961). (In Russian)

A double scintillation coincidence spectrometer was used in investigating Eu^{147} , Eu^{149} , and Eu^{151} . It is assumed that all three nuclides have h_{in} levels which initiate M-2 transitions and also E-3 transitions in Eu^{147} and Eu^{149} . The Gd fraction separated from Ta target bombarded by 660-Mev protons was used as the source. Gamma quanta of 230, 380 (370 to 396), 500, 620, 750, 900, 1100, 1300, 1550, and 1750 kev were observed in the Gd^{147} spectrum. The coincidence spectrum for the Gd^{147} 230 kev quanta and the spectrum of retarded coincidences for the Gd^{147} 625 kev quanta are plotted. The 625 kev energy is isomeric with $T_{1/2} = (7.1 \pm 0.4) \times 10^{-7}$ sec. The 230, 400, and 625 kev quanta coincide with 370 and 930 kev quanta, and possibly with 510 and 570 kev. The decay scheme of Eu^{147} based on the data is in agreement with published data. The γ quanta for Gd^{149} are in agreement with previous data. The spectra of instantaneous and retarded coincidences for the Gd^{149} 150-kev quanta are developed, and it is shown that the 150, 350, and 500 kev quanta coincide with the 300 kev quanta. It is confirmed that the 496 kev level is isomeric with $T_{1/2} = (2.48 \pm 0.05) \times 10^{-6}$ sec. The spectra of delayed coincidences for the Gd^{151} 300 and 175 kev quanta show that the 175 kev quanta coincide with the 155 kev. Coincidences for the 243 kev quanta were

not observed; the transition for the 243 kev was not found in the 175-kev cascade. (R.V.J.)

18761 MEASUREMENTS OF HALF-LIFE OF FIRST EXCITED STATES OF Tb^{159} AND Yb^{173} BY MEANS OF MULTICHANNEL-TIME ANALYZER. E. E. Berlovich, M. P. Bonits, and V. V. Nikitin (Ioffe Inst. of Physics and Technology, Academy of Sciences, USSR). *Izvest. Akad. Nauk S.S.S.R., Ser. Fiz.*, 25: 218-27 (Feb. 1961). (In Russian)

The design and specifications are given for a multichannel time analyzer capable of measuring life times of 10^{-11} to 10^{-10} sec. The apparatus is applied in determining the life time of the Tb^{159} 58-kev level and the Yb^{173} 79-kev level. The results indicate for Tb^{159} $T_{1/2} = (1.3 \pm 0.4) \times 10^{-10}$ sec and for Yb^{173} $T_{1/2} = (3.8 \pm 0.5) \times 10^{-11}$ sec. The transition probabilities, g-factors, and Q_0 are analyzed and correlated with published data. (R.V.J.)

18762 COEFFICIENTS OF K X-RAY FLUORESCENCE OF V^{51} , Mn^{55} , Cu^{65} , and Ga^{71} . A. A. Konstantinov, I. A. Sokolova, and T. E. Sazonova. *Izvest. Akad. Nauk S.S.S.R., Ser. Fiz.*, 25: 228-32 (Feb. 1961). (In Russian)

Coefficients of K x-ray fluorescence were determined by an absolute count of Auger K-electrons and the number of K x rays from a given source. The coefficients for V^{51} (Cr^{51}), Mn^{55} (Fe^{55}), Cu^{65} (Zn^{65}), and Ga^{71} (Ge^{71}) were found and tabulated. (R.V.J.)

18763 GAMMA EMISSION OF Ta^{182} . N. A. Voinova, B. S. Dzhelepov, and Yu. V. Khol'nov (Khlopin Radium Inst., Academy of Sciences, USSR). *Izvest. Akad. Nauk S.S.S.R., Ser. Fiz.*, 25: 233-6 (Feb. 1961). (In Russian)

The complex spectrum of Ta^{182} , with 70 known γ rays divided into weak (up to 350 kev) and strong (850 to 1450 kev) lines, was studied. The spectrum of photoelectrons from bismuth, knocked out by Ta^{182} γ rays, was plotted and soft γ rays were tabulated. The strong γ lines of Ta^{182} were also plotted and tabulated after corrections for absorption and sensitivity. Studies were made of the spectrum at 1600 kev in order to verify the existence of the previously reported line at 1608 kev. The results indicate that if this line exists, its intensity does not exceed 0.05% of the 1121.6 kev line. (R.V.J.)

18764 PROTON RADIATIVE CAPTURE BY S^{34} . Yu. P. Antuf'ev, A. K. Val'ter, V. Yu. Gonchar, E. G. Kopanets, A. N. L'vov, and S. P. Tsytiko (Inst. of Physics and Tech., Academy of Sciences, Ukr. SSR). *Izvest. Akad. Nauk S.S.S.R., Ser. Fiz.*, 25: 265-9 (Feb. 1961). (In Russian)

Proton radiative capture by S^{34} at 1241 kev was investigated. Measurements were made on the γ spectra by single-crystal spectrometer and double-crystal coincidences. The angular distribution of γ rays and γ - γ correlations were measured, and the γ yield from a thick S^{34} target was determined. (R.V.J.)

18765 MEASUREMENTS OF THE γ QUANTA YIELD IN ONE EVENT OF Mo^{99} DECAY. A. N. Silant'ev, (Khlopin Radium Inst., Academy of Sciences, USSR). *Izvest. Akad. Nauk S.S.S.R., Ser. Fiz.*, 25: 270-1 (Feb. 1961). (In Russian)

The number of γ quanta per Mo^{99} decay was measured by 4 π β - γ coincidences. The experimental γ -coincidence spectrum was plotted with considerations for background coincidences and γ energies, and the yield per decay was tabulated. The data are in good agreement with published data. The intensity of the 920-kev line is explained by a coincidence of two quanta and transition from the 922-kev level to the ground state. (R.V.J.)

18766 MEASUREMENTS OF THE NUMBER OF γ QUANTA PER ONE Ba^{140} AND Pr^{144} DECAY. B. S. Kuznetsov and A. N. Silant'ev (Khlopin Radium Inst., Academy of Sciences, USSR). *Izvest. Akad. Nauk S.S.S.R., Ser. Fiz.*, 25: 272-3 (Feb. 1961). (In Russian)

The number of γ quanta per Ba^{140} and Pr^{144} decay was measured by $4\pi \beta\text{-}\gamma$ coincidence. The chemical separation of Ba from La and Pr from Ce was performed chromatographically. The number of γ quanta per Ba^{140} decay and the energy and intensity are tabulated and compared with previous data. Considering that 7% of the decays (5% γ and 2% conversion electron) are at 162 keV then 93% take place at 30 keV (15% γ rays). The conversion coefficient of the above transition is 5.2 (type M1). The spectrum for Pr^{144} coincidences was plotted and the number of quanta per decay at 695 keV was found to be 0.012. (R.V.J.)

18767 CONVERSION TRANSITIONS IN Th^{229} α DECAY AND Ra^{225} ENERGY LEVELS. E. F. Tret'yakov, N. I. Pirogova, and L. L. Gol'din (Inst. of Theoretical and Experimental Physics, the Academy of Sciences, USSR). *Izvest. Akad. Nauk S.S.S.R., Ser. Fiz.*, 25: 274-82 (Feb. 1961). (In Russian)

The spectrum of Ra^{225} conversion electrons was studied by β spectrometry. Coincidences with γ rays ($\gamma\text{-e}_K$) and $e_K\text{-}\gamma$ were used in addition to $\alpha\text{-e}_K$. The γ quanta were recorded by a scintillation spectrometer with a NaI(Te) crystal, amplifier, and single channel analyzer. Two specimens of U^{233} containing various amounts of Th^{229} and Th^{229} were used. The internal conversion spectrum for Th^{229} was plotted. Conversion lines for Ra^{225} were tabulated and analyzed. In some cases total intensity of ($e_K\text{-}\gamma$) transitions is given. The transition multiplicity was determined by the relations $L_I : L_{II} : L_{III} : K : L$, and $x : \gamma$ intensities. A new scheme is developed for Ra^{225} lower levels. (R.V.J.)

18768 ELECTROMAGNETIC MULTIPLICITY TRANSITIONS $L = [J_i - J_f] + 1$. M. E. Voikhanskii (Leningrad Chemical-Pharmaceutical Inst.). *Izvest. Akad. Nauk S.S.S.R., Ser. Fiz.*, 25: 283-6 (Feb. 1961). (In Russian)

Data on nuclear level lifetimes in relation to γ emission are usually compared with theoretical evaluations of the probability of single partial transitions according to the independent particle model. According to these evaluations the partial half-times in relation to radiative transitions are determined by the expressions developed for $T_{1/2}^\gamma(\text{EL})$ and for $T_{1/2}^\gamma(\text{ML})$. Within the examined model the $T_{1/2}^\gamma(\text{EL})$ and $T_{1/2}^\gamma(\text{ML})$, as functions of spin levels J_i and J_f , are included in the statistical multiplier $S(J_i L J_f)$. Tables are given of the statistical multipliers $S(J_i L J_f)$ for EL and ML transitions with $L = [J_i - J_f]$ and $[J_i - J_f] + 1$. The tables of statistical multiplier $S(J_i L J_f)$ for transitions between the $J_i = J_f \equiv J$ states and expressions for M_μ for four possible magnetic-type transitions are also included. (R.V.J.)

18769 PROPERTIES OF DEFORMED ODD-ODD NUCLEI WITH $K = 0^+$. D. A. Varshalovich and L. K. Peker (Scientific Research Inst. of Physics, Leningrad State Univ. and Inst. of Physics and Tech., Academy of Sciences, USSR). *Izvest. Akad. Nauk S.S.S.R., Ser. Fiz.*, 25: 287-96 (Feb. 1961). (In Russian)

Properties of rotational levels in odd-odd nuclei are studied, and the results are applied to the excited states of even-even nuclei containing unpaired nucleons. It is shown that in spite of the identical states of odd neutrons and protons, the intrinsic wave functions describing the same rotational levels are different for levels with odd and even spin I . The rotation band for an odd-odd nucleus with $K = \Omega_p - \Omega_n = 0$ and the scheme of Ho^{166} are plotted. A table

of odd-odd nuclei with $I = 1$, β decay to daughter nuclei with $I = 0^+$ and 2^+ , shows that Ta^{180^*} ($T_{1/2} = 8.15$ h) and Am^{242} ($T_{1/2} = 16$ h) have $K = 0^+$. The magnitude K can be explained by the Nilsson scheme, where it is anticipated that $\Omega_p = \Omega_n$ and $K = [\Omega_p - \Omega_n] = 0^-$; ${}_{73}\text{Ta}^{180^*}(p_{3/2}^- [514], n_{9/2}^+ [624], \text{ or } p_{7/2}^+ [404], n_{7/2}^- [514])$; ${}_{95}\text{Am}^{242}(p_{5/2}^- [523], n_{5/2}^+ [622])$. The same should apply to the isomer state of Lu^{176} ($T = 3.7$ h) with spin $I = 1$. The analogue should hold for Np^{240} ($T = 7.3$ min) with spin $I = 1^+$ (probable configuration $p_{5/2}^+ [642]$ and $n_{5/2}^+ [622]$ with $K = 0$). The electric quadrupole and magnetic dipole moments of odd-odd nuclei with $K = 0$ and $I = 1$ (Lu^{176} , Ta^{180} , and Am^{242}) are tabulated. The probability of γ -transitions between rotational levels and the properties of light odd-odd and even-even nuclei with $K = 0$ are discussed. The level schemes for Na^{22} and Al^{26} are given. (R.V.J.)

18770 SELECTION RULES FOR β - AND γ TRANSITIONS IN ODD-ODD NUCLEI. M. E. Voikhanskii and L. K. Peker (Scientific Research Inst. of Physics, Leningrad State Univ. and Leningrad Chemical-Pharmaceutical Inst.). *Izvest. Akad. Nauk S.S.S.R., Ser. Fiz.*, 25: 297-308 (Feb. 1961). (In Russian)

The asymptotic rules for β and γ transitions in odd-odd nuclei are analyzed, and certain peculiarities in the transitions are compared with transitions in nuclei with odd A . Tables are given of β transitions in deformed nuclei with even A , of β transitions in spherical nuclei with even A , of isomeric second class transitions in deformed odd-odd nuclei, and of M4 type transitions in odd-odd spherical nuclei. (R.V.J.)

18771 YIELD OF γ EMISSION IN INELASTIC NEUTRON SCATTERING ON ANTIMONY NUCLEI. D. L. Broder, A. I. Lashuk, and I. P. Sadokhin. *Izvest. Akad. Nauk S.S.S.R., Ser. Fiz.*, 25: 309-12 (Feb. 1961). (In Russian)

The yield of 1.01 MeV γ quanta in inelastic neutron scattering on antimony nuclei was measured. The gamma radiation was studied with a crystal spectrometer with a 40×40 mm NaI(Tl) crystal and a half-width for the Zn^{65} (1.12 MeV) line of $\sim 9\%$. Neutrons were obtained by the $\text{H}^3(p,n)\text{He}^3$ reaction with 1.5 to 3.3 MeV protons. The yield of 0.84 MeV γ quanta from iron was studied in order to obtain an absolute γ yield in inelastic neutron scattering as a function of energy. Gamma spectra at $E_\gamma = 0.5$ to 1.5 MeV and $E_n = 1.4$ and 2.2 MeV were plotted, and the γ yield ($E_\gamma = 1.01$ MeV) appearing in inelastic neutron scattering on antimony is analyzed. (R.V.J.)

18772 MERCURY ION BEAM SPUTTERING OF METALS AT ENERGIES 4-15 Kev. G. K. Wehner and D. Rosenberg (General Mills, Inc., Minneapolis). *J. Appl. Phys.*, 32: 887-90 (May 1961).

Sputtering yields for 14 metals from the 4th, 5th, and 6th periods are measured for normally incident Hg^+ ions at energies between 4 and 15 keV. The sputtering rate is determined by measuring the time required for the ion beam to pierce a target foil. Results for the various metals show that yields at high energy behave similarly to yields previously found at lower ion energy, i.e., yields are closely linked to the position of the metal in the periodic chart. Yields increase in the 4th period from Ti through V, Fe, Co, Ni to Cu and in a similar fashion in the 5th period to Ag and in the 6th period to Au. It is suggested that Cu, Ag, and Au atoms with their more closely filled d shells behave more nearly like hard spheres, and thus produce the higher sputtering yields. (auth)

18773 THE GAMMA-RAY SPECTROMETRY OF FISSION PRODUCTS. II. Calculated Gamma-Ray Scintillation

Spectra of U^{235} Fission Products with a Well Type NaI(Tl) Crystal. Ich. Hattori (Ishikawajima-Harima Heavy Ind. Co., Ltd., Japan). J. Atomic Energy Soc. Japan, 3: 179-85(Mar. 1961). (In Japanese)

The gamma spectra of a fission product mixture are combined with the crystal data, and the gamma scintillation spectra for a well-type NaI (Tl) scintillation crystal are computed. Similar calculations yield the spectra of Np^{239} , produced by the reactions $U^{238} + n \rightarrow U^{239} \rightarrow Np^{239} + \beta^-$. Results are given that predict recording spectra for gamma spectrometers as functions of time after fission. The spectra are composed of five peaks in the lower energy range and four peaks in the higher one, which depend fairly strongly upon decay time. During the first 3 weeks after fission, peaks IV and VII decay below detection. Peak X, which exists under the background at the first day after fission, appears about 3 days after fission and reaches maximum height 2 weeks after fission. After a 50 to 200 day period, peaks V, X, and VI decay below detection. About 18 months after fission, peak VII reappears. About 2 years after fission, Peak VIII disappears and the spectrum possesses only peaks I, II, III, and VII. About 7 years after fission, peaks I, II, and III decay and only peak VII remains. (auth)

18774 AN EXPERIMENTAL TEST OF THE STATISTICAL THEORY OF NUCLEAR REACTIONS. D. L. Allan (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nuclear Phys., 24: 274-99(1961). (In English)

The 14 Mev differential (n,p) cross sections of about 40 nuclei are measured at 120° to the incident neutrons using a photographic plate method. The results are compared with the cross sections calculated according to the statistical theory of nuclear reactions, and it is shown that good agreement exists between theory and experiment provided a level density function of the form $\exp(2aU)^{1/2}$ with a $\approx 1/10$ A is used and the pairing energy δ is taken into account. Experimental values of δ and the nuclear temperatures are given. The (n,np) cross sections of 13 of the nuclei are measured and the results are discussed in terms of a reaction mechanism based on the statistical model. (auth)

18775 PENETRATION MATRIX ELEMENTS AND NUCLEAR STRUCTURE EFFECTS IN Tl^{203} . T. R. Gerholm, B.-G. Pettersson, B. Van Nooijen, and Z. Grabowski (Univ. of Uppsala). Nuclear Phys., 24: 177-95(1961). (In English)

Gamma-gamma, electron-gamma, and gamma-electron directional correlation experiments on the $d_{5/2}$ (400 kev) $d_{5/2}(279 \text{ kev})s_{1/2}$ cascade in Tl^{203} are reported. The following results are obtained: $A_2(\gamma\gamma) = -0.130 \pm 0.006$, $A_2(e\gamma) = -0.011 \pm 0.004$, $A_2(\gamma e) = -0.030 \pm 0.003$. In addition the K-conversion coefficient of the 400 kev transition is determined from the coincidence experiments. The value obtained is $\beta_K^{400} = 0.145 \pm 0.007$. The experiments were performed in order to search for nuclear structure effects in the M1 internal conversion process. These effects are expected to be negligible in the l-allowed (400 kev) transition. This is confirmed by the experiments, which are in perfect agreement with the theory assuming no nuclear structure effects. Large nuclear structure effects are to be expected for the strongly retarded l-forbidden (279 kev) transition. This is also confirmed by the angular correlation experiments. All experimental data are consistent with a λ -value of $+76 \pm 1$, where λ is defined as the ratio of the penetration matrix element and the normal gamma ray matrix element. The value for the weighting factor $C(Z,k)$ is taken to be 0.0260. The errors for λ do not include the uncertainty in the weighting factor, which is supposed to be known to within

$\pm 10\%$. The agreement between the theory and the experimental results is further improved if the particle parameters are corrected for the finite size of the nucleus in the E2 conversion process. (auth)

18776 PENETRATION MATRIX ELEMENTS AND NUCLEAR STRUCTURE EFFECTS IN Tl^{201} . B.-G. Pettersson, T. R. Gerholm, Z. Grabowski, and B. Van Nooijen (Univ. of Uppsala). Nuclear Phys., 24: 196-222(1961). (In English)

Nuclear structure effects in internal conversion in Tl^{201} are discussed. Gamma-gamma, electron-gamma, and gamma-electron correlations are measured. The following results are obtained: $A_2(946 + 907\gamma - 330\gamma) = +0.72 \pm 0.04$, $A_2(946 + 907\gamma - 330e) = +0.210 \pm 0.007$, $A_2(361\gamma - 330\gamma) = -0.20 \pm 0.08$, $A_2(361\gamma - 330e) = -0.09 \pm 0.01$, $A_2(361e - 330\gamma) = +0.001 \pm 0.004$, $A_2(585\gamma - 330e) = +0.022 \pm 0.015$, and $A_2(585\gamma - 361e) = -0.013 \pm 0.008$. From coincidence and single counting rates the following conversion coefficients are determined: $\alpha_K^{(330)} = 0.113 \pm 0.008$, $\alpha_K^{(361)} = 0.21 \pm 0.025$, $\alpha_K^{(585)} = 0.06 \pm 0.01$. A decay scheme including 17 transitions and 9 excited states is established. The angular correlations and conversion coefficients are used to determine the spins and parities for the first, second, and fifth excited states as well as the multipolarities, characters, and mixing ratios of the most intense transitions. The results are analyzed in terms of nuclear structure effects in the conversion process. For the $d_{5/2} \rightarrow d_{5/2}$ M1 transition there is no evidence for nuclear structure effects, in agreement with theory. For the strongly retarded l-forbidden $d_{5/2} \rightarrow s_{1/2}$ M1 transition the experimental data are in agreement with the theory for $\lambda = +74 \pm 3$, where λ is defined as the ratio of the penetration matrix element and the corresponding gamma ray matrix element. The value for the weighting factor $C(Z,k)$ is 0.0274. The errors for λ do not include the uncertainty in the weighting factor which is supposed to be known to within $\pm 10\%$. Thus the large nuclear structure effects in the internal conversion process for the 279 kev transition in Tl^{203} are analogous to those for the 330 kev transition in Tl^{201} . The λ -values for these two transitions are in agreement. Corrections for static finite size effects in the E2 conversion process are small, as in the case of Tl^{203} . It is concluded that the present formulation of the theory of internal conversion, including nuclear structure dependent factors, is fully consistent with the experimental data. Experimentally determined penetration matrix elements provide new information about the nuclear structure. It is shown that a unique determination of the λ -parameter necessitates determination of both the internal conversion coefficient and the electron-gamma angular correlation. (auth)

18777 MAGNETIC AND QUADRUPOLE INTERACTIONS IN Hg^{197m} . ANGULAR CORRELATIONS. B.-G. Pettersson, J. E. Thun, and T. R. Gerholm (Univ. of Uppsala). Nuclear Phys., 24: 223-42(1961). (In English)

A series of electron-gamma angular correlation studies of the 165-134 kev cascade in Hg^{197m} and the 130-279 kev cascade in the decay-product Au^{197m} are reported. The experiments are undertaken primarily to settle the problem of the possible existence of a time dependent coupling between the nucleus and the electron core, excited by virtue of a preceding conversion or electron-capture process. For the Au^{197m} cascade no observable attenuations of the angular correlation pattern are found because of the short lifetime (2.3×10^{-11} s) of the intermediate level. In Hg^{197m} , where the corresponding lifetime is 1×10^{-8} s, the correlation is found to be attenuated by a static quadrupole interaction for carrier-free sources deposited onto different

metal and insulator backings. No measurable attenuation due to an interaction with the electron core is seen for metallic source backings. However, an additional attenuation attributed to the aftereffects of the conversion-process is found for sources embedded in insulating environments. The interplay between the two different types of interaction gives a complicated attenuation mechanism, which, however, can be disentangled by means of time-differential angular correlations. A direct proof of the existence of an attenuation-effect due to the excitation of the electron core is furnished by a magnetic decoupling experiment, confirming the results obtained in the correlation experiments. (auth)

18778 EXPERIMENTAL DETERMINATION OF THE CONVERSION COEFFICIENT OF THE 412 Kev E2 TRANSITION IN Hg^{198} . B.-G. Pettersson, J. E. Thun, and T. R. Gerholm (Univ. of Uppsala). Nuclear Phys., 24: 243-50 (1961). (In English)

The K-conversion coefficient of the 412 kev transition in Hg^{198} is measured using a coincidence method. The result obtained, $\alpha_K = 0.0305 \pm 0.0010$, is in agreement with the theoretical value for a pure E2 transition, and in disagreement with results obtained by the internal-external conversion method. (auth)

18779 PENETRATION MATRIX ELEMENTS AND NUCLEAR STRUCTURE EFFECTS IN Ta^{181} . Z. Grabowski, B.-G. Pettersson, T. R. Gerholm, and J. E. Thun (Univ. of Uppsala). Nuclear Phys., 24: 251-68(1961). (In English)

Gamma-gamma and electron-gamma angular correlations in Ta^{181} are measured. The following results are obtained: $G_2A_2(133\gamma - 137\gamma - 482\gamma) = -0.065 \pm 0.003$, $G_2A_2(137\gamma - 482\gamma) = -0.04 \pm 0.015$, $G_2A_2(133K - 482\gamma) = -0.118 \pm 0.005$, $G_2A_2(137K - 482\gamma) = +0.030 \pm 0.013$, $G_2A_2(133\gamma + 137\gamma - 482K) = -0.005 \pm 0.003$, and $A_2(346\gamma - 136K) = +0.02 \pm 0.01$. The quadrupole attenuation factor G_2 is determined by delayed angular correlations and found to be the same in the gamma-gamma and electron-gamma correlations. The value obtained is $G_2 = 0.22 \pm 0.015$. An independent determination of G_2 gives $G_2 = 0.23 \pm 0.015$. Two conversion coefficients were determined from electron-gamma coincidence data: $\alpha_K(133) = 0.54 \pm 0.08$ and $\alpha_K(482) = 0.026 \pm 0.002$. The results are used to analyze the 482 kev conversion process in terms of nuclear structure dependent conversion matrix elements. The 482 kev transition is of mixed E2/M1 character. The mixing ratio becomes $\delta(482) = 6.4 \pm 0.8$. The M1 conversion process is strongly affected by the penetration terms. The M1 conversion coefficient is about 10 times larger than the normal finite size corrected value. From the conversion coefficient and the angular correlations the parameter λ , defined as the ratio of the penetration matrix element and the normal gamma-ray matrix element, becomes $-70 \geq \lambda \geq -125$. The large λ -value is a consequence of the large retardation of the 482 kev M1 transition. For the strongly retarded 133 kev E2 transition, however, the conversion process is found to be normal. It is concluded that the spin of the 619 kev level is $+\frac{5}{2}$ in disagreement with earlier tentative assignments. (auth)

18780 ON THE DETERMINATION OF THE IMAGINARY POTENTIAL IN THE OPTICAL MODEL. J. Olkowsky and J. Raynal (Centre d'Etudes Nucleaires, Saclay, France). Nuclear Phys., 24: 269-73(1961). (In French)

The Bjorklund-Fernbach optical model is applied to the determination of the imaginary potential W fitting the $\text{Pr}^{141}(p,n)$ reaction cross section at energies less than 11.1 Mev. The reaction cross section is found to be more sen-

sitive to the shape of the imaginary potential than to its depth. (auth)

18781 A NEW VARIATIONAL METHOD FOR CALCULATING EXCITED ENERGY LEVELS AND ITS APPLICATION TO THE ANHARMONIC OSCILLATOR. Kazuo Yamazaki (Max-Planck-Institut für Physik und Astrophysik, Munich). Nuclear Phys., 24: 313-17(1961). (In English)

A simple variational method for calculating the excited levels of a quantal system is developed and is applied as an illustration to the anharmonic oscillator. For this case, the method agrees in the weak coupling limit with the perturbation calculation, and also agrees with the exact values within a 1% error in the strong coupling limit. (auth)

18782 INVESTIGATIONS ON THE DECAY SCHEME OF I^{131} IN THE LOW ENERGY REGION OF GAMMA-RAYS. Gy. Mathe, T. Scharbert, and D. Berenyi (Inst. of Nuclear Research, Hungarian Academy of Sciences, Debrecen). Nuclear Phys., 24: 318-21(1961). (In English)

The γ energy region below 364 kev, found in $\text{I}^{131} \beta^-$ decay, is examined by scintillation techniques; ordinary and sum-coincidence methods are used. A cascade of 156-210 kev is found, with an intensity $\approx 1\%$ of the cross-over transition intensity from the 364 kev level to the ground state. The existence of the 177 kev line is confirmed. (auth)

18783 CONCERNING THE CALCULATION OF THE NUCLEAR MOMENT OF INERTIA. S. T. Beliaev (Kurchatov Atomic Energy Inst., Academy of Sciences, Moscow). Nuclear Phys., 24: 322-5(1961). (In English)

Using the generalized method of canonical transformation, an expression for the nuclear moment of inertia is found with allowances for nucleon pairing. The result coincides with that obtained by the Green's function method. (auth)

18784 NUCLEAR INTERACTIONS IN THE SHELL MODEL. S. P. Pandya and S. K. Shah (Physical Research Lab., Ahmedabad, India). Nuclear Phys., 24: 326-33(1961). (In English)

A central two-body interaction that fits the energy levels of the $(d_{3/2})$, $(d_{5/2})$ and $(d_{3/2})(d_{5/2})^{-1}$ configurations observed in K^{38} and Cl^{36} is deduced. It is shown that this does not explain the very small splittings of the $s_{1/2}$ -particle doublets in P^{30} , P^{32} , etc. (auth)

18785 THE ELASTIC SCATTERING OF 29 Mev He^3 BY Al, V, AND Cu. G. W. Greenlees (Univ. of Birmingham, Eng.), J. S. Lilley, P. C. Rowe, and P. E. Hodgson. Nuclear Phys., 24: 334-9(1961). (In English)

Absolute differential cross sections are presented for the elastic scattering of 29 Mev He^3 by Al, V, and Cu in the angular range 15° to 80° c.m. The results are fitted by an optical model potential with a Saxon-Woods form factor and no spin orbit term. (auth)

18786 ACTIVATION CROSS SECTIONS FOR (n,p) REACTIONS IN SOME MEDIUM-WEIGHT NUCLEI WITH D + D NEUTRONS. J. J. Van Loef (Universidad de Chile, Santiago). Nuclear Phys., 24: 340-5(1961). (In English)

Activation cross sections for (n,p) reactions with D + D neutrons are reported on Fe^{54} , Ni^{61} , and Zn^{67} and compared with published (n,p) cross sections in Fe^{54} , Ni^{60} and Zn^{64} . The (n,p) cross sections of the even target nuclei are much greater than those of the odd-neutron nuclei; among even nuclei they are highest for 28 closed shell Fe^{54} and Ni^{60} . (auth)

18787 FAST PHOTO NEUTRONS FROM BISMUTH. A. Wataghin (Centro Brasileiro de Pesquisas Fisicas, Rio

de Janeiro), R. B. Costa, A. M. Freire, and J. Goldenberg. *Nuovo cimento* (10), 19: 864-71 (Mar. 1, 1961). (In English)

The energy spectrum of the photo-neutrons emitted from a bismuth target irradiated with 22 Mev bremsstrahlung is studied at angles of 30° , 90° , and 150° to the γ -beam, using nuclear emulsions. An excess of high energy neutrons above the evaporation spectrum exists at all angles of observation. The angular distributions can be described by the formula $A + B \sin^2 \theta + C \cos \theta$. The average value of the ratio B/A is 0.68 ± 0.15 and the average value of $C/A = 0.155 \pm 0.056$. The variation of B/A with energy is studied. Data indicate a maximum value of B/A around 5.5 Mev. (auth)

18788 STUDY BY MEANS OF NUCLEAR EMULSIONS, OF TERNARY FISSION OF U^{235} BOMBARDED BY THERMAL NEUTRONS. J. Catala, V. Domingo, and J. Casanova (Facultad de Ciencias, Valencia). *Nuovo cimento* (10), 19: 923-8 (Mar. 1, 1961). (In Spanish)

The results were presented of a study of 1,000 fission events in U^{235} , in which a light particle was emitted. Nuclear emulsions were used. Because of the large number of events analyzed, it was possible to obtain data of good statistical accuracy on the frequency of emission of light particles, on their angular distribution, and on the upper limit of their energy spectrum. Also determined were the mean ranges, masses, and energies of the light particles and of the heavy fragments. (auth)

18789 ON THE POLARIZATION OF PROTONS IN (d,p) STRIPPING REACTIONS. E. Coffou (Inst. "Rudjer Boskovic", Zagreb). *Nuovo cimento* (10), 19: 1055-7 (Mar. 1, 1961). (In English)

The polarization and angular distribution of the ejected protons are given as functions of the polarization of the incident deuterons, assuming unpolarized target nuclei. A distorted-wave Born approximation is used to give the scattering amplitude. Special cases are examined, including that of unpolarized deuterons. (T.F.H.)

18790 ON THE DECAY OF THE Tc^{95} ISOMER. G. Chilosi, R. A. Ricci, G. Varcaccio, and G. B. Vingiani (Universita, Naples and Istituto Nazionale di Fisica Nucleare, Naples). *Nuovo cimento* (10), 19: 1121-30 (Mar. 16, 1961). (In English)

The γ -ray spectrum following the radioactive decay of Tc^{95} is investigated by scintillation techniques. The sources are obtained by $Mo^{95}(d,2n)$ reactions. The measurements are performed with a NaI(Tl) well type crystal (76 mm \times 76 mm) and the different spectra are displayed in a 200 channel analyzer. γ - γ cascades are investigated with a conventional coincidence arrangement, using the summing technique. The direct disintegration of the isomeric state of Tc^{95} to stable Mo^{95} , in competition with the 39 kev isomeric transition to the Tc^{95} ground state, is confirmed. Excited levels of 1040, 820, 780, and 203 kev are assigned to the Mo^{95} structure, de-exciting mostly with the following transitions, in kev: 1040 (5 ± 1), 838 (38 ± 4), 820 (13 ± 2), 780 (17 ± 2), 580 (50 ± 5), and 203 (100). (auth)

18791 ANGULAR DISTRIBUTION OF PHOTOFISSION FRAGMENTS FROM URANIUM. H. G. de Carvalho (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro), A. G. Da Silva, and J. Goldemberg. *Nuovo cimento* (10), 19: 1131-41 (Mar. 16, 1961). (In English)

The angular distributions of photofission fragments from uranium at x-ray maximum energies of 6.9, 8.1, 9.4, 15.5, and 20 Mev were measured using a 24 Mev betatron. The anisotropy was found to increase with decreasing x-ray energy and to be mainly consistent with an $a + b \sin^2 \theta$ electric dipole photon absorption distribution. The quadrupole

contribution was shown to be small. The ratio of the anisotropic dipole absorption to the isotropic fission yields at the three lowest x-ray energies was 2.80 ± 0.44 , 1.18 ± 0.14 , and 0.62 ± 0.12 , respectively. At 15.5 and 20 Mev the distributions are almost isotropic. (auth)

18792 POLARIZATION OF Co^{57} IN Fe METAL. J. G. Dash, R. D. Taylor, D. E. Nagle, P. P. Craig, and W. M. Visscher (Los Alamos Scientific Lab., N. Mex.). *Phys. Rev.*, 122: 1116-24 (May 15, 1961).

A study is made of the effect of low temperatures on the resonant emission and absorption of the 14.4 kev Mossbauer radiation from Fe^{57} in Fe metal. Analysis of intensity changes in the hyperfine spectrum is made, in terms of the Zeeman level splittings of the ground states of both Fe^{57} absorbing nuclei and Co^{57} parent nuclei. The theory for the temperature dependence is developed in terms of the properties of the Co^{57} decay and of the subsequent gamma transitions. Experiments are carried out with a source of Co^{57} nuclei in Fe metal at temperatures between 4.5 and $0.85^\circ K$. The results, analyzed in terms of the theory, yield a value of the hyperfine magnetic field at the Co^{57} nuclei. Comparison of the result with other experimental values indicates that depolarization of the nuclei by the K-capture decay of Co^{57} is not evident. (auth)

18793 APPLICATION OF THE IMPULSE APPROXIMATION TO THE SCATTERING OF ELECTRONS BY ATOMS. I. INELASTIC SCATTERING BY HYDROGEN ATOMS. R. Akerib (Convair, San Diego, Calif.) and S. Borowitz. *Phys. Rev.*, 122: 1177-84 (May 15, 1961).

A calculation of the ionization cross section and the excitation cross section to the 2S and 2P states of hydrogen atoms by collision with electrons is carried out by the use of an impulse approximation. The results are compared to the experimental data and to other calculations. The cross sections obtained compare well with experiment. The calculations carried out by these methods are no more complicated than the usual approximation methods and are easily adaptable for use with more complicated atoms. (auth)

18794 NUCLEAR SPIN-SPIN INTERACTION ENERGY IN THE HYDROGEN MOLECULE. J. P. Auffray and J. W. Cooley (New York Univ., New York). *Phys. Rev.*, 122: 1203 (May 15, 1961).

An accurate theoretical estimate of the interaction energy of the two proton magnetic moments in the $v = 0$, $J = 1$ vibrational-rotational level of the electronic ground state of H_2 is obtained. Agreement with the experimental value for the nuclear spin-spin interaction energy is found to be within 1 part in 10^3 . This is of the order of magnitude of the experimental error. (auth)

18795 SYMMETRIC AND ASYMMETRIC FISSION. Henry W. Newson (Duke Univ., Durham, N. C.). *Phys. Rev.*, 122: 1224-6 (May 15, 1961).

Fission yields are calculated assuming as a first approximation that they are proportional to the product of the level densities of a pair of binary fission products. The level densities are calculated with simplified shell-model methods. The calculations predict a single symmetric peak when the mass of the fissioning nucleus, A_0 , is less than 210 (in agreement with the observed fission yields for bismuth and lighter elements), and three maxima in the fission yield curves for heavier compound nuclei. The peak corresponding to approximately equal-size binary fission products is very much higher than is observed experimentally. This is undoubtedly due to the fact that in asymmetric fission a core corresponding to 82 neutrons and 50 protons remains intact in the heavier fission prod-

uct, whereas for symmetric fission this core is disrupted at the cost of several Mev. Since correction for this energy effect involves a number of unknown factors, the calculated yields for symmetric fission are reduced by the same empirical factor in all calculations. An additional parameter, n , is introduced in correcting for excitation energy of the fission products and for possible departures from equilibrium. The correction calculations, which involve only two free parameters, explain most of the fission yield data for all five known cases (Pu^{239} , U^{238} , U^{235} , U^{233} , and Th^{232}) where the compound nucleus is within a Mev or so of the fission threshold, but it is necessary to treat n as a free parameter for each curve to fit the small steep regions on each side of mass number $\frac{1}{2}A_0$. The calculated fission yields of the more highly excited compound nucleus, Ac^{227} , predict three equally prominent maxima in qualitative agreement with observation. (auth)

18796 GAMMA-GAMMA DIRECTIONAL CORRELATIONS IN Nd^{147} . Atam P. Arya (Pennsylvania State Univ., University Park). Phys. Rev., 122: 1226-31(May 15, 1961).

Directional correlation measurements are made on the 320 to 92 keV and 280 to 320 keV gamma-ray cascades in Pm^{147} following the decay of 11.1 day Nd^{147} with a coincidence scintillation spectrometer using NaI detectors. The observed correlation functions are: $W(\theta) = 1 - (0.1030 \pm 0.0298) P_2(\cos\theta) + (0.0107 \pm 0.0099) P_4(\cos\theta)$, and $W(\theta) = 1 + (0.0710 \pm 0.0162) P_2(\cos\theta) - (0.0126 \pm 0.0103) P_4(\cos\theta)$, respectively, for the two cascades. The energy levels of Pm^{147} at ground state, 92, 410, and 690 keV are found to be $\frac{1}{2}^+$, $\frac{1}{2}^+$, $\frac{1}{2}^+$, and $\frac{5}{2}^+$, respectively. It is found that the 92 keV gamma ray has a mixture of $(95 \pm 2)\%$ M1 and $(5 \pm 2)\%$ E2 with $\delta_{92} = + (0.229 \pm 0.143)$; the 320 keV gamma ray has a mixture of 1% M1 and 99% E2 with $\delta_{320} = +9.95 \pm 0.11$; and the 280 keV gamma ray has a mixture of 99% M1 and 1% E2 with $\delta_{280} = -0.11 \pm 0.11$. (auth)

18797 NUCLEAR ENERGY LEVELS OF Na^{24} IN THE REGION FROM 350 TO 630 KeV. Carl T. Hibdon (Argonne National Lab., Ill.). Phys. Rev., 122: 1235-48(May 15, 1961).

The neutron cross section of Na^{24} from 350 to 630 keV shows 71 peaks, consisting of a relatively small number of large peaks and many small peaks. Each of the large peaks is resolved into two or more components. The analyses show a few s- and p-wave levels, and a large number of d- and f-wave levels. For all of the levels of Na^{24} up to 630 keV, a plot of the number of levels having energies $\leq E_n$ as a function of the neutron energy E_n shows an essentially linear distribution. The distribution of the angular momenta is in agreement with the theoretical distribution for a value of $\sigma = 1.8$. The level spacings agree with an exponential distribution. For the reduced neutron widths, the results agree equally well with the exponential and Porter-Thomas distributions. The strength function obtained from the reduced widths has an average value of 0.045 for both values of J for $l = 0$ and an average value of 0.37 for all values of J for $l = 1$. For higher values of l , the strength function is too large. An expression developed for the distribution of the levels above the ground state tends to agree with the data for a value of 0.50 MeV for δ , the average level spacing of the nucleons in the nucleus. (auth)

18798 (d,p) REACTIONS IN DEFORMED HEAVY NUCLEI. G. B. Holm, J. R. Burwell, and D. W. Miller (Indiana Univ., Bloomington, Ind.). Phys. Rev., 122: 1260-6(May 15, 1961).

The spectra of protons from (d,p) nuclear reactions initiated by 11 MeV deuterons incident on Th^{232} , U^{233} , U^{235} , U^{238} , and Pu^{239} are obtained using separate isotopic targets. The

protons are analyzed in a double-focusing magnetic spectrometer. States with assignments known from radioactive-decay studies are identified and assignments for some other observed states are discussed using the Nilsson model and Satchler's theory of (d,p) reactions in deformed nuclei. From an analysis of the results the following binding energies of the last neutron are obtained: U^{234} , 6.83 ± 0.11 MeV; U^{239} , 4.74 ± 0.06 MeV; and Pu^{240} , 6.49 ± 0.05 MeV. (auth)

18799 DECAY OF Zn^{63} . J. B. Cumming and N. T. Porile (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 122: 1267-74(May 15, 1961). (BNL-5149)

The decay of 38.4 min Zn^{63} is investigated using scintillation and beta spectrometer techniques. 84% of the decays are to the Cu^{63} ground state. Gamma rays having energies of 0.67, 0.96, and 1.42 MeV are present with intensities of 9.0, 6.7, and 0.9% of the β^+ transitions. Low intensity gamma rays ($<0.2\%$) are observed at energies of 1.55, 1.83, 2.04, 2.34, 2.55, 2.77, and 3.10 MeV. Coincidence measurements established positron feeding of the Cu^{63} levels at 0.67, 0.96, and 1.42 MeV but no $\gamma\text{-}\gamma$ coincidences are observed. Internal conversion coefficients of the 0.67 and 0.96 MeV gamma rays are in agreement with predominantly M1 assignments to both transitions. A decay scheme is presented. It is inferred that the spin of Zn^{63} is $\frac{3}{2}^-$. M1 and E2 transition probabilities between the various levels of Cu^{63} and Cu^{65} are discussed in terms of the "center-of-gravity" model for states in these nuclei. Both agreements and disagreements with the model predictions are observed. (auth)

18800 COULOMB EXCITATION OF THE SECOND 2+ STATES IN W, Os, AND Pt NUCLEI. F. K. McGowan and P. H. Stelson (Oak Ridge National Lab., Tenn.). Phys. Rev., 122: 1274-80(May 15, 1961).

The location of a second 2+ state is established for six even-even nuclei by means of Coulomb excitation produced by 4 to 5 MeV protons. The relatively weak excitation of these states is detected by a measurement of the gamma-ray yields from singles spectra and from coincident measurements of the cascade gamma rays. The $B(E2)$'s for decay of the second 2+ state to ground state by the crossover transition exhibit some uniformity for the even-even isotopes of W and Os, being about 6 times the single-particle value. The cascade/crossover ratio for the decay of the second 2+ state is known for these nuclei. The upper cascade $B(E2)$'s exhibit enhancements of 10 to 60 times the single-particle value. The ratios of the $B(E2)$'s for decay of the first and second 2+ states are compared to the predictions of several collective models. For five of these nuclei the E2/M1 ratio is known for the upper cascade transition. The $B(M1)$ values obtained are exceedingly small compared to the single-particle estimate. This result is in qualitative agreement with the collective models which predict that M1 radiation is forbidden in the decay of vibrational excitations. (auth)

18801 FAST NEUTRON ACTIVATION CROSS SECTION OF Au^{197} . S. A. Cox (Argonne National Lab., Ill.). Phys. Rev., 122: 1280-2(May 15, 1961).

The neutron activation cross section of gold was measured in the neutron range from 30 to 1500 keV. The absolute value of the cross section was based on the U^{235} fast fission cross section, which was used for absolute neutron flux measurements from 200 to 1500 keV. For measurements below 200 keV, the $\text{B}^{10}(n,\alpha)$ cross section was used for monitoring the neutron flux. The relative cross section from 30 to 200 keV was then normalized at 200 keV to the absolute measurement. (auth)

18802 EXCITATION FUNCTIONS FOR THE ($\alpha, \alpha n$) AND ($\alpha, 2pn$) REACTIONS ON Ce^{142} . B. M. Foreman, Jr. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 122: 1283-5 (May 15, 1961). (BNL-5152)

Cross sections are measured radiochemically for the reactions $\text{Ce}^{142}(\alpha, \alpha n)\text{Ce}^{141}$ and $\text{Ce}^{142}(\alpha, 2pn)\text{Ce}^{143}$ at a helium-ion energy of 16.8 to 40.1 Mev. The cross section for the ($\alpha, \alpha n$) reaction begins to rise sharply at about 25 Mev and reaches a value of 69 ± 5 mb at 40.1 Mev. The cross section for the ($\alpha, 2pn$) reaction begins to rise at about 32 Mev and reaches a value of 2.5 ± 0.4 mb at 40.1 Mev. An upper limit of ~ 0.1 mb for the cross section for the reaction $\text{Ce}^{142}(\alpha, \alpha p)\text{La}^{141}$ in the energy range covered is also obtained. The results for the ($\alpha, \alpha n$) and ($\alpha, \alpha p$) reactions are discussed in terms of several mechanisms: compound nucleus formation and decay, knock-on, and direct inelastic scattering followed by neutron evaporation. The results seem to be most consistent with the last mechanism. The existence of a measurable cross section for the ($\alpha, 2pn$) reaction in this energy region suggests that the reaction proceeds mainly by He^3 emission, probably by a stripping mechanism. The data reported are consistent with the hypothesis that in this energy range at most one particle is emitted as a result of direct interaction. (auth)

18803 SYMMETRY OF NEUTRON-INDUCED U^{235} FISSION AT INDIVIDUAL RESONANCES. G. A. Cowan, Anthony Turkevich, and C. I. Browne (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 122: 1286-94 (May 15, 1961).

Neutrons in the resonance energy region from a nuclear explosion are resolved by time-of-flight and are used to induce fissions in U^{235} attached to a revolving wheel. The symmetry of fission at individual resonances from approximately 10 to 60 ev is examined by radiochemical means. As measured by the yield ratio of $\text{Ag}^{111}/\text{Mo}^{99}$, the probability of symmetric fission decreases at some resonances by a maximum of 10% compared to thermal fission of U^{235} and at other resonances increases by a maximum of 40%. With varying degrees of assurance, nine resonances are identified with an increase in symmetry; five more regions of increased symmetry are associated with resonances or a background effect. Twenty resonances are identified with a decrease in symmetry. In a sample containing 500 levels in the resonance region, there is no level with a Ag^{111} yield even one-thirtieth as great as the Mo^{99} yield. It is thus improbable that there are any neutron resonances in U^{235} that lead to predominantly symmetric fission. (auth)

18804 DECAY OF Er^{172} AND Tm^{172} . C. J. Orth and B. J. Dropesky (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 122: 1295-1301 (May 15, 1961).

Er^{172} is produced by double neutron capture in enriched Er^{170} . The beta decays of 50.4 hr Er^{172} and its daughter, 63.7 hr Tm^{172} , are studied with a solenoidal beta spectrometer and with beta and gamma scintillation spectrometers. The highest energy group of the Tm^{172} beta spectrum has an end point energy of 1.83 Mev; this group represents the $\text{Tm}^{172} \rightarrow \text{Yb}^{172}$ ground-state beta transition. The beta decay of Tm^{172} is accompanied by gamma rays of the following energies: 0.079, 0.180, 0.422, 0.495, 0.915, 1.095, 1.29, 1.39, 1.41, 1.47, 1.51, and 1.59 Mev. A decay scheme for Tm^{172} is proposed with excited states in Yb^{172} at 0.079, 0.259, 1.174, 1.47, 1.55, 1.59, and 1.67 Mev. The beta decay of Er^{172} is accompanied by gamma rays of the following energies: 0.050 (Tm K x ray), 0.108, 0.126, 0.408, and 0.610 Mev, the last of which represents a transition to the Tm^{172} ground state. The beta spectrum measured in coincidence with the 0.610-Mev gamma ray has an end-point

energy of ~ 0.26 Mev, which establishes a decay energy of 0.87 Mev for Er^{172} . (auth)

18805 SPIN AND HYPERFINE STRUCTURE OF ARSENIC-76. R. L. Christensen, D. R. Hamilton, H. G. Bennewitz, J. B. Reynolds, and H. H. Stroke (Princeton Univ., N. J.). Phys. Rev., 122: 1302-16 (May 15, 1961). (PUC-1960-20)

Hyperfine structure in the $^4\text{S}_{3/2}$ ground state of the radioactive atom As^{76} is investigated by the method of magnetic resonance in an atomic beam produced by microwave discharge dissociation of arsenic vapor. $\Delta F = 0$ resonances are observed within both the $F = 5/2$ and $F = 1/2$ atomic levels at several values of magnetic field up to about 5 gauss, indicating that the spin of the As^{76} nucleus is 2. An analysis of multiple quantum transition spectra within the same F states gives a measurement for two of the hfs intervals: $\Delta\nu_{7/2, 5/2} = \pm(117 \pm 4)$ Mc and $\Delta\nu_{5/2, 3/2} = \pm(69 \pm 16)$ Mc, with the same sign for both. From the value of the hfs constant A, the magnitude of the magnetic field at the arsenic nucleus is $(1.33 \pm 0.15) \times 10^5$ gauss in reasonable agreement with the variation in this field among similar atoms. The value of g_j is found to be 1.994 ± 0.003 for arsenic. (auth)

18806 PHOTOPRODUCTION OF PIONS IN CARBON. T. R. Palfrey, B. M. K. Nefkens, L. Mortara, and F. J. Loeffler (Purdue Univ., Lafayette, Ind.). Phys. Rev., 122: 1323-30 (May 15, 1961).

Positive and negative pions are produced by photons on a carbon target and observed at laboratory angles of 35° , 73° , and 121° . At each angle the yield of mesons of constant energy is observed by a magnetic spectrometer as a function of peak bremsstrahlung energy E. Seven values of E ranging from 205 to 335 Mev are used. Yields and π^-/π^+ ratios corrected for various systematic experimental errors are presented. By using a photon difference method the bremsstrahlung spectra are unfolded from the yield curves to give meson cross sections versus photon energy at fixed pion energies. These functions are compared with predicted yields that consider the internal momentum distribution of the target nucleons. (auth)

18807 COMPARISON OF THE SCATTERING OF POSITRONS AND ELECTRONS FROM NUCLEAR CHARGE DISTRIBUTIONS. George H. Rawitscher (Yale Univ., New Haven) and C. Rutherford Fischer. Phys. Rev., 122: 1330-7 (May 15, 1961).

Elastic scattering cross sections of 183 Mev positrons and electrons are calculated for various charge distributions of Ca and Au scattering nuclei. It is shown that the combined use of positron and electron scattering measurements can lead to a determination of the nuclear charge distribution that is more accurate than that derived from either one of the scattering cross sections used alone. The scattered particles obey Dirac's equation and the nuclei are assumed to be static spherically symmetric charge distributions, whose radial dependence is given in terms of a three-parameter family of curves. (auth)

18808 THE EMISSION OF CHARGED PARTICLES FROM THE BOMBARDMENT OF SILVER WITH NITROGEN IONS. J. S. Lilley (Univ. of Birmingham, Eng.). Proc. Phys. Soc. (London), 77: 833-44 (Apr. 1, 1961).

A silver foil of 4.4 mg cm^{-2} was bombarded with a (N^{14}) ion beam, and the reaction products were recorded in C2 emulsion. The energy and angular distributions of the emitted protons and α -particles were measured and the results at large angles were compared with predictions of evaporation theory. Agreement was obtained by assuming that the Coulomb barrier was reduced at high nuclear

excitations. The presence of competing direct processes was discussed. (auth)

18809 AN INVESTIGATION OF SOME (t,d) REACTIONS IN LIGHT NUCLEI AT 5.5 MeV. F. de S. Barros, P. D. Forsyth, A. A. Jaffe, and I. J. Taylor (Univ. of Manchester, Eng.). Proc. Phys. Soc. (London), 77: 853-65(Apr. 1, 1961).

A broad range magnetic spectrograph is used to analyze the deuterons emitted from targets of natural boron, carbon, silicon dioxide and aluminum bombarded with 5.5 Mev tritons. The angular distributions of the majority of the deuteron groups from the reactions observed in B^{10} , C^{12} , C^{13} , O^{16} , Al^{27} , and Si^{28} are measured and information is also obtained on (t,d) reactions in Mg^{24} , Si^{28} , and Ca^{40} because of the presence of these nuclei as impurities in the targets. In all cases the measured excitation energies of the final nuclei are in agreement with accepted values. The angular distributions are compared with stripping theory and also with published data on (d,p) transitions between the same initial and final nuclear states. Where possible the ratios of the yields of corresponding (t,d) and (d,p) reactions are compared with the predictions of stripping theory to extract values of the proportionality constant of the momentum transform of the deuteron within the triton, $|A_0|^2 N_1^2$. The values obtained vary between $18.0 \times 10^{12} \text{ cm}^{-1}$ for the transition from B^{10} to the ground state of B^{11} and $1.3 \times 10^{12} \text{ cm}^{-1}$ for the transitions from O^{16} to the ground state of O^{17} and from Si^{28} to the 3.630 Mev excited state of Si^{29} . At 5.5 Mev triton bombarding energy, therefore, a constant value of $|A_0|^2 N_1^2$ cannot be used to extract values of nucleon reduced widths from studies of (t,d) reactions. (auth)

18810 EFFECTIVE CROSS SECTIONS FOR CERTAIN (α, α') , (α, t) , (α, d) and (α, p) REACTIONS ON LITHIUM NUCLEI. K. V. Makaryunas (Inst. of Physics and Mathematics, Academy of Sciences, Lithuanian SSR). Trudy Akad. Nauk Litovskoi S.S.R., Ser. B, No. 1, 117-20(1961). (In Russian)

Measurements of effective cross sections for $Li^7(\alpha, \alpha')$, $Li^{7*}(Q = 4.61 \text{ Mev})$, $Li^7(\alpha, t) Be^9(-2.56)$, $Li^8(\alpha, d) Be^9(-1.59)$, $Li^8(\alpha, p) Be^9(-2.13)$, and $Li^7(\alpha, p) Be^{10}(-2.56)$ reactions at α energies from 8.34 to 14.7 Mev are given. The results are explained by reaction mechanisms differing from compound nucleus formation. (tr-auth)

18811 ANGULAR DISTRIBUTION OF 12 MEV PROTONS INELASTICALLY SCATTERED ON Li^7 AND Li^7 NUCLEAR SPIN AT 4.61 MEV LEVEL. K. V. Makaryunas (Inst. of Physics and Mathematics, Academy of Sciences, Lithuanian SSR). Trudy Akad. Nauk Litovskoi S.S.R., Ser. B, No. 1, 121-3(1961). (In Russian)

Angular distribution data for 12-Mev proton inelastic scattering on Li^7 are compatible with the spin of the 4.61 Mev level, equal to 7/2, as predicted by the shell model. (tr-auth)

18812 ON THE MECHANISM OF $Be^9(\alpha, n)C^{12}$ REACTION AT $E_\alpha = 3.22 \text{ Mev}$. K. V. Makaryunas (Inst. of Physics and Mathematics, Lithuanian Academy of Sciences, SSR). Trudy Akad. Litovskoi S.S.R., Ser. B, No. 1, 125-7(1961). (In Russian)

The direct interaction mechanism in the $Be^9(\alpha, n)C^{12}$ reaction ($Q = 5.71$) at an α energy of 3.22 Mev was studied and compared with the experimental angular distribution. Considering the reaction as knock-out, $a = 3.9 \times 10^{-13} \text{ cm}$ and as stripping, $a = 3.5 \times 10^{-13} \text{ cm}$. (R.V.J.)

18813 ANGULAR DISTRIBUTION OF 14-Mev NEUTRONS AFTER ELASTIC SCATTERING BY ATOMIC NUCLEI. V. I. Strizhak, V. V. Bobir, and L. Ya. Grona (Inst. of Physics, Academy of Sciences, Ukrainian SSR). Ukrain. Fiz. Zhur., 5: 702-3(Sept.-Oct. 1960). (In Ukrainian)

The angular distribution of neutrons from the $D(T,d)He^4$ reaction after elastic scattering by carbon, silver, mercury and cadmium with an energy of 14 Mev has been determined using a stilbene scintillation counter and a photomultiplier for detection. With the exception of carbon, the data obtained for the other elements are in good agreement with the theory. A graphical presentation of the data is given using the method employed by F. Bjorklund and S. Fernblach (Second Geneva Conference, 1958, Paper No. P/343). (TTT)

18814 ANGULAR DISTRIBUTION OF 2.9-Mev NEUTRONS AFTER ELASTIC SCATTERING BY ATOMIC NUCLEI. V. I. Strizhak, A. O. Kozar, and M. S. Nazarov (Inst. of Physics, Academy of Sciences, Ukrainian SSR). Ukrain. Fiz. Zhur., 5: 704(Sept.-Oct. 1960). (In Ukrainian)

The elastic scattering of 2.9-Mev neutrons by carbon, nickel, selenium, zirconium, molybdenum and tellurium has been determined in the angular range of 25 to 150°, using neutrons from the $D(d,n)He^4(E_d = 175 \text{ Kev})$ reaction. The angular distribution has been measured by means of an ionization chamber. Corrections have been made to account for multiple scatterings and for the attenuation of the beam. (TTT)

18815 STRIPPING OF ALPHA PARTICLES FROM Be^9 , C^{12} AND O^{16} NUCLEI. E. V. Inopin (Inst. of Physics and Tech., Academy of Sciences, Ukr., SSR). Ukrain. Fiz. Zhur., 5: 750-1(Nov.-Dec. 1960). (In Russian)

The cross section of α -particle stripping from Be^9 , C^{12} , and O^{16} during collision with target nuclei was computed on the basis of an alpha particle model applied to these nuclei. The nuclei targets are considered as absolutely black, the radius being considerably larger than that of the bombarding nuclei. The effect of Coulomb repulsion is not considered. The expressions $\sigma_1^2 = 2\pi R d$, $\sigma_1^3 = \sigma_2^3 = \frac{3}{2}\pi R d$, $\sigma_1^4 = \sigma_2^4 \approx 1.22\pi R d$, $\sigma_1^5 \approx 1.05\pi R d$ (where R is the nucleus-target radius and d is the distance between α particles in the bombarding nucleus) are obtained for the n -particle stripping cross sections σ_n^N from a nucleus consisting of N particles. (auth)

18816 TENSOR FORCES IN DIRECT INELASTIC SCATTERING. G. L. Vysotskii (Inst. of Physics and Tech., Academy of Sciences, Ukr., SSR). Ukrain. Fiz. Zhur., 5: 752-6(Nov.-Dec. 1960). (In Ukrainian)

The cross section of direct inelastic scattering of nucleons by nuclei is considered in the Born approximation, taking into account the tensor forces between the projectile and the outer nucleon. (auth)

18817 ON THE SCATTERING OF DEUTERONS BY ORIENTED NON-SPHERICAL NUCLEI. Yu. A. Berezhoni (Inst. of Physics and Tech., Academy of Sciences, Ukr., SSR). Ukrain. Fiz. Zhur., 5: 757-61(Nov.-Dec. 1960). (In Ukrainian)

Diffraction scattering of fast deuterons oriented by non-spherical nuclei with arbitrary spin was studied. Formulas are obtained for integral cross sections of the scattering, absorption, and diffraction splitting of deuterons, the stripping of a neutron or proton, and the distribution by energies of neutrons liberated during stripping. Numerical computations of integral cross sections are carried out for spin values $\frac{3}{2}$, $\frac{5}{2}$, $\frac{7}{2}$, and $\frac{9}{2}$. (tr-auth)

18818 EFFECT OF THE CHOICE OF THE DEUTERON WAVE FUNCTION ON THE MAGNITUDE OF THE STRIPPING CROSS SECTIONS AND THE DIFFRACTION SPLITTING. V. K. Tartakovskii. Ukrain. Fiz. Zhur., 5: 769-72(Nov.-Dec. 1960). (In Ukrainian)

Integral cross sections are found for the processes of the diffraction interaction of high-speed deuterons with black

nuclei (splitting cross section, diffraction splitting, elastic scattering, and absorption of deuterons), employing Hulthén's function as a wave function of the basic state of the deuteron and the function allowing for the finite radius of action of nuclear forces. All cross sections, except that of deuteron absorption, increase, as compared with the corresponding cross sections computed by the deuteron wave function $\varphi_0(r) = \sqrt{(\alpha)/(2\pi)} \cdot (e^{-\alpha r})/(r)$. (auth)

18819 THE SPECTRUM OF ENERGY-RICH PROTONS FROM THE REACTION $O^{16}(\gamma, p)N^{15}$. U. Hegel and E. Finckh (Universität, Heidelberg). Z. Physik, 162: 142-53(1961). (In German)

Oxygen gas was irradiated with 34.5 Mev bremsstrahlung. The spectrum of protons between 6 and 22 Mev was measured with a NaI(Tl) scintillation spectrometer. The energy resolution was equivalent to that obtainable with nuclear photoplates, but the number of protons registered was much higher. The differential cross section for (γ, p) reactions that leave the residual nucleus in the ground state was found to be 0.13 mb/steradian at 30 Mev gamma ray energy and at 90° with respect to the direction of the incident beam. (auth)

18820 MEASUREMENT OF THE PHOTOPROTONS FROM ARGON AND OXYGEN. E. Finckh and U. Hegel (Universität, Heidelberg). Z. Physik, 162: 154-9(1961). (In German)

A thin CsI(Tl) crystal was used to measure the yield of photoprotons for a 34.5 Mev bremsstrahlung spectrum. The following values relative to the yield of the $C^{12}(\gamma, n)$ reaction were obtained: 2.45 ± 0.35 for argon and 2.06 ± 0.28 for oxygen. An upper limit of the integrated cross section for the (γ, n) and (γ, p) reaction in oxygen is given. (auth)

18821 β - γ CIRCULAR POLARIZATION CORRELATION IN Sc^{46} AND V^{48} . H. Daniel and M. Kuntze (Max Planck-Institut für Kernphysik, Heidelberg). Z. Physik, 162: 229-34(1961). (In German)

The β - γ circular polarization correlation was measured for Sc^{46} and V^{48} by comparison with Co^{60} . The Co^{60} value was assumed to be $A = -1/3$. The values for Sc^{46} and V^{48} were found to be $A = 0.10 \pm 0.02$ and $A = 0.00 \pm 0.04$, respectively. This excludes large Fermi-Gamow-Teller interference terms. Small interference terms are somewhat more likely than pure Gamow-Teller transitions in both cases. (auth)

18822 β - γ POLARIZATION CORRELATION IN THE β -DECAY OF Sc^{46} . V. M. Lobashov, V. A. Nazarenko, and L. I. Rusinov (Leningrad Inst. of Physics and Tech., Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz., 40: 10-12(Jan. 1961). (In Russian)

The correlation between the β -electron transverse polarization and γ -quantum circular polarization has been measured. The magnitude of the correlation is proportional to an interference term of the type $Im(VT, SA)$. The experimental data indicate with a statistical accuracy of $\sim 30\%$ that no such term exists and this is not inconsistent with the existing theory of β decay. (auth)

18823 RADIATIONS FROM Eu^{145} , Eu^{146} , AND Eu^{147} . N. M. Anton'eva, A. A. Bashilov, B. S. Dzhelepov, K. G. Kaun, A. F. A. Meier, and V. B. Smirnov (Leningrad State Univ.). Zhur. Eksptl'. i Teoret. Fiz. 40: 23-8(Jan. 1961). (In Russian)

The europium and gadolinium fractions separated from Ta irradiated by 680-Mev protons were investigated by means of a magnetic spectrometer and luminescent γ -spectrometer. New γ -transitions have been detected. The relative intensities of hard γ -rays from Eu^{146} have been

determined. More precise values have been determined for the energies as well as intensities of the conversion lines due to previously observed γ -transitions in the decay of Eu^{145} ($T_{1/2} = 5.6 \pm 0.3$ days), Eu^{146} ($T_{1/2} = 4.6 \pm 0.3$ days) and Eu^{147} ($T_{1/2} = 25$ days). The conversion electron spectrum of the europium fraction was measured between ~ 20 and ~ 2600 kev and the hard γ -ray spectrum was investigated up to 3500 kev. The level schemes of Eu^{145} , Eu^{146} , and Eu^{147} are discussed. (auth)

18824 DIFFERENCES IN THE LATTICE CONSTANTS OF NEON ISOTOPES. V. S. Kogan, B. G. Lazarev, and R. F. Bulatova (Physics and Technology Inst., Academy of Science, Ukrainian, SSR). Zhur. Eksptl'. i Teoret. Fiz., 40: 29-31(Jan. 1961). (In Russian)

Roentgenographic investigations of the neon isotopes Ne^{20} and Ne^{22} were carried out at $4.2^\circ K$. Both isotopes have face-centered cubic lattices with the constants $\alpha = 4.471 \pm 0.004$ Å (Ne^{20}) and $\alpha = 4.455 \pm 0.004$ Å (Ne^{22}). The difference in the molar volumes ($\Delta V/V = (1.1 \pm 0.05\%)$) is in satisfactory agreement with the results of calculations performed by taking into account the differences in energy of the zero vibrations. The difference in the molar volumes of the neon isotopes is much greater than that for the lithium isotopes which, according to data in the literature, is negligible despite the larger mass difference than that in neon isotopes. This apparently is due to the difference in the nature of the binding forces in the neon and lithium lattices. (auth)

18825 A STUDY OF LOW-LYING EXCITED STATES IN Mn^{56} AND Ho^{166} BY MEASURING CASCADE γ -QUANTUM COINCIDENCES. A. S. Melioranskii, I. V. Estulin, and L. F. Kalinkin (Moscow State Univ.). Zhur. Eksptl'. i Teoret. Fiz., 40: 64-71(Jan. 1961). (In Russian)

The technique for measurement of the intensity of cascade γ -quanta was employed to investigate the low-lying levels of the odd-odd nuclei Mn^{56} and Ho^{166} . The multipolarity of the 25 and 85 kev radiative transitions in Mn^{56} was determined. The level scheme of the strongly deformed Ho^{166} nucleus, which exhibits a rotational band is discussed. (auth)

18826 MEASUREMENT OF THE CIRCULAR POLARIZATION OF THE γ -QUANTA EMITTED IN β -DECAY OF Nd^{147} . A. A. Petushkov and I. V. Estulin (Moscow State Univ.). Zhur. Eksptl'. i Teoret. Fiz., 40: 72-5(Jan. 1961). (In Russian)

The asymmetry coefficient for $\beta\gamma$ -correlation was determined by measuring the degree of circular polarization of 530-kev γ -quanta accompanying the β -decay of Nd^{147} and found to be $A = -0.093 \pm 0.15$. This value is consistent with a spin of $j = 7/2$ of the investigated excited state of Pm^{147} for a multipole mixture corresponding to a radiation transition $E2 + M1$ possessing an amplitude ratio $E2/M1$ equal to $+1.75 \pm 0.15$. (auth)

18827 ON THE LEVEL SCHEME OF Eu^{153} . L. I. Rusinov, R. L. Aptekar, V. S. Gvozdev, S. L. Sakharov, and Yu. L. Khazov (Leningrad Inst. of Physics and Tech.). Zhur. Eksptl'. i Teoret. Fiz., 40: 79-84(Jan. 1961). (In Russian)

The decay scheme of Sm^{153} ($T_{1/2} = 47$ hours) obtained in the (n, γ) -reaction was investigated. The γ -transition types were determined for transitions with energies of 69.7 kev (96.4% $M1 + 3.6\%$ $E2$); 83.4 kev (60% $M1 + 40\%$ $E2$); 103.2 kev (98.5% $M1 + 1.5\%$ $E2$) and 98 kev ($M1$). The 98 kev transition has been observed for the first time. The experimental results are compared with the theory. Some new details of the level scheme of Eu^{153} are presented. (auth)

18828 INVESTIGATION OF THE (γ, n) REACTION ON Sn^{112} AND Sn^{124} ISOTOPES. Chi-ti Kuo, B. S. Ratner, and B. V. Sergeev (Lebedev Inst. of Physics, Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz., 40: 85-7 (Jan. 1961). (In Russian)

The yield curves for the (γ, n) reaction on Sn^{112} and Sn^{124} isotopes were measured by the induced radioactivity method. The peaks in the cross section curves for the reactions $\text{Sn}^{112}(\gamma, n)\text{Sn}^{111}$ and $\text{Sn}^{124}(\gamma, n)\text{Sn}^{123}$ are located respectively at 16.0 ± 0.5 and 15.5 ± 0.5 Mev. The corresponding integral cross sections are 1.82 ± 0.10 and 1.56 ± 0.08 Mev barn. (auth)

18829 OBSERVATION OF RESONANCE ABSORPTION OF γ -RAYS IN Zn^{67} . S. I. Aksenov, V. P. Alfimenkov, V. I. Lushchikov, Yu. M. Ostanevich, F. L. Shapiro, and Wu-kuang Yen (Lebedev Inst. of Physics, Academy of Science, USSR and Joint Inst. for Nuclear Research, Dubna, USSR). Zhur. Eksptl'. i Teoret. Fiz., 40: 88-90 (Jan. 1961). (In Russian)

Experiments on recoilless resonance absorption of Zn^{67} 92-keV γ -rays are described. A positive result has been obtained for metallic zinc at liquid helium temperature. However, the effect is very small. (auth)

18830 DECAY SCHEME OF Te^{131m} . A. Bedesku, O. M. Kalinkina, K. P. Mitrofanov, A. A. Sorokin, N. V. Forafontov, and V. S. Shpinel (Moscow State Univ.). Zhur. Eksptl'. i Teoret. Fiz., 40: 91-100 (Jan. 1961). (In Russian)

The γ - and β -radiations accompanying the decay of the Te^{131m} ($T_{1/2} = 30$ hours) isomer were measured with a scintillation γ -coincidence spectrometer, a two-lens β -spectrometer and $\beta\gamma$ -coincidence spectrometer. A decay scheme for the Te^{131m} nucleus is proposed. Levels at 0.15, 0.60, 0.78, 0.92, 1.62, 1.82, 1.92, 2.0, and 2.24 Mev have been established for the daughter I^{131} nucleus. The spins and parities of a number of levels have been determined from the data pertaining to the multipolarities and relative intensities of the γ - and β -transitions. (auth)

18831 INVESTIGATION OF SHORT-PERIOD ISOMER ACTIVITIES PRODUCED BY IRRADIATING Ga, Ge, AND As NUCLEI WITH 19.2 MeV PROTONS. A. M. Morozov (Inst. of Chemical Physics, Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz., 40: 101-4 (Jan. 1961). (In Russian)

More precise data relating to the short-period isomer activities previously detected by irradiating gallium, germanium and arsenic nuclei with fast protons are presented. A more detailed investigation revealed that when germanium is irradiated, two short-period activities arise. One of them is produced by the reaction $\text{Ge}^{76}(p, 2n)\text{As}^{76m}$ and the other apparently in the reaction $\text{Ge}^{72}(p, pn)\text{Ge}^{71m}$. The isomer activities due to gallium and arsenic bombardment appear as a result of the reactions $\text{Ga}^{71}(p, n)\text{Ge}^{71m}$ and $\text{As}^{75}(p, p')\text{As}^{76m}$, respectively. The energy dependence of the cross sections for the reactions $\text{Ge}^{71}(p, n)\text{Ge}^{71m}$ and $\text{Ge}^{76}(p, 2n)\text{As}^{76m}$ are measured from the threshold of the reaction up to 19.2 Mev. (auth)

18832 POLARIZATION OF SOME RADIOACTIVE ISOTOPES IN ALLOYS CONTAINING IRON. A. V. Kogan, V. D. Kul'kov, L. P. Nikitin, N. M. Reinov, I. A. Sokolov, and M. F. Stel'makh (Leningrad Inst. of Physics and Tech., Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz., 40: 109-13 (Jan. 1961). (In Russian)

Polarization of the nuclei of Au^{199} , Ir^{192} , Ir^{191m} , Re^{186} , and V^{48} in an alloy containing iron was studied at ultra-low temperatures. The magnetic field acting on the nuclei of the admixture isotopes $H_{\text{eff}} \approx 2.10^6$ Oe for Au^{199} , $H_{\text{eff}} \approx$

2.10^5 Oe for Re^{186} and $H_{\text{eff}} \sim 10^6$ Oe for Ir^{192} . No polarization was found in the Ir^{191m} isomer produced as a result of β -decay of Os^{191m} introduced in the iron and in V^{48} in an alloy containing iron and 2% of titanium. The comparatively small value of H_{eff} for Re^{186} may be due to the large disorientation of the nuclei during the β -transition. The growth of H_{eff} with increasing atomic number of the weakly magnetic admixture qualitatively agrees with the theory proposed by Marshall. (auth)

18833 ON THE THEORY OF DOUBLE ELECTRON AND NUCLEAR RESONANCE IN SYSTEMS WITH HYPERFINE INTERACTION. T. G. Izyumova and G. V. Skrotskii (Ural Polytechnic Inst.). Zhur. Eksptl'. Teoret. Fiz., 40: 133-42 (Jan. 1961). (In Russian)

The complex susceptibility of electron spins interacting with a nuclear system is computed on the basis of statistical perturbation theory. The dependence of the conditions for saturation of the electron system on resonance conditions of the nuclear system is determined. (auth)

18834 SUPERFLUIDITY OF NUCLEAR MATTER. L. P. Rapoport and S. G. Kadenskii (Voronezh State Univ., USSR). Zhur. Eksptl'. i Teoret. Fiz., 40: 183-93 (Jan. 1961). (In Russian)

The possibility of existence of superfluidity of nuclear matter and He^3 for real interactions between fermions in the S-state is considered by Bogolyubov's method. It is shown that in the normal state near the Fermi surface, repulsion but not attraction predominates for nucleon pairs with opposite momenta and spins. However, because of renormalization of the repulsion term in the compensation equation, nuclear matter may be superconductive. The reason that He^3 is not superfluid is given. (auth)

18835 MACROSCOPIC EQUATIONS FOR THE MAGNETIC MOMENT IN SOME MAGNETIC RESONANCE PROBLEMS. N. N. Korst (Inst. of Chemical Physics, Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz., 40: 249-55 (Jan. 1961). (In Russian)

A method is proposed for transition from the Bloch equations for the density matrix to equations for the macroscopic magnetic moment of a nuclear system consisting of interacting spins. As an example of application of the method the problem of three equivalent spin- $1/2$ particles coupled to each other by dipole-dipole interaction is considered. The solution of the equations is given. (auth)

18836 PAIR CORRELATION EFFECTS NEAR CLOSED SHELLS. S. I. Drozdov and D. F. Zaretskii. Zhur. Eksptl'. i Teoret. Fiz., 40: 286-95 (Jan. 1961). (In Russian)

Pair correlation effects are investigated for nuclei near to closed shells. Equations for the Green's functions are obtained. The accuracy of these equations is shown to be of the order of $A^{-1/2}$. A possibility for experimental verification of the results by means of stripping or pickup reactions is indicated. (auth)

18837 ON THE DETERMINATION OF THE FREQUENCY DISTRIBUTION FUNCTION OF THE PHONON SPECTRUM OF CRYSTALS. Yu. Kagan. Zhur. Eksptl'. i Teoret. Fiz., 40: 312-18 (Jan. 1961). (In Russian)

The problem of constructing the distribution function for the phonon spectrum frequencies of crystals of arbitrary symmetry is considered in connection with investigation of single phonon transitions in the Mossbauer effect and non-coherent scattering of cold neutrons. (auth)

18838 HIGHER NUCLEON CHARGE AND MAGNETIC MOMENT DISTRIBUTION MOMENTS. V. B. Berestetskii and M. V. Terent'ev. Zhur. Eksptl'. i Teoret. Fiz., 40: 324-7 (Jan. 1961). (In Russian)

Unitarity relations in which only two-pion intermediate states are taken into account are employed to calculate the nucleon charge and magnetic moment distribution moments. Asymptotic expressions for the charge and magnetic moment distribution moments are derived. Deviations of the electron-nucleon scattering phase shifts from the values pertaining to a point nucleon are evaluated. (auth)

18839 PAIRING FORCES AND PAIR CORRELATIONS IN THE Pb^{208} NUCLEUS. V. N. Guman, L. A. Sliv, and G. A. Sogomonova (Leningrad Inst. of Physics and Tech., Academy of Sciences, USSR). *Zhur. Eksptl'. i Teoret. Fiz.*, 40: 341-51 (Jan. 1961). (In Russian)

Residual pairing forces acting between nucleons in the nucleus are determined. The importance of taking these pairing forces into account in determining the position and properties of the levels is demonstrated. The energies, eigenfunctions, and transition probabilities of the Pb^{208} nuclear levels are derived and compared with the experiments. (auth)

18840 GAMMA TRANSITIONS IN Sm^{146} . E. E. Berlovich, V. N. Klement'ev, L. V. Krasnov, and M. K. Nikitin (Leningrad Inst. of Physics and Tech., Academy of Sciences, USSR). *Zhur. Eksptl'. i Teoret. Fiz.*, 40: 375-7 (Jan. 1961). (In Russian)

Samples containing mainly Gd^{146} (60 days) and its daughter isotope Eu^{146} (5 days) were separated chromatographically from a Ta target irradiated with 660-Mev protons from a cyclotron. The gamma transitions were followed on a scintillation coincidence counter coupled with a 100-channel analyzer. It is assumed that Sm^{146} is formed by electron capture in Eu^{146} . A decay scheme for Sm^{146} is presented on the basis of the coincidences observed at 2.1, 1.8, 1.5, 1.3, 1.1, and 0.9 Mev. (TTT)

18841 INVESTIGATION OF THE PARAMAGNETISM OF μ -MESIC ATOMS. L. B. Egorov, G. V. Zhuravlev, A. E. Ignatenko, Hsuan-ming Li, M. G. Petrashku, and D. Chultem (Joint Inst. for Nuclear Research, Dubna, USSR). *Zhur. Eksptl'. i Teoret. Fiz.*, 40: 391-9 (Feb. 1961). (In Russian)

The nature of the paramagnetism of various mesic atoms was investigated by measuring the asymmetry of μ -decay electrons. The results of the experiments indicate that in dielectrics, diamagnetic and weakly paramagnetic normal metals paramagnetism of mesic atoms is caused by the μ -meson magnetic moment, whereas in paramagnetic transition metals, lanthanides and actinides it is due to the magnetic moments of the electron shell and of the meson. It is shown that polarized mesons can be employed as a means of investigating the magnetic properties of atoms and the hydrides of the transition metals, actinides and lanthanides which possess zero nuclear spin. (auth)

18842 INTERACTION OF 660 Mev PROTONS WITH CARBON, NITROGEN AND OXYGEN NUCLEI. N. A. Perfilov and Yu. I. Serebrennikov (Radium Inst., Academy of Sciences, USSR). *Zhur. Eksptl'. i Teoret. Fiz.*, 40: 400-8 (Feb. 1961). (In Russian)

Three-layer photographic plates (a 2μ thick gelatin layer between two 100μ thick emulsion layers) were used to record 1044 disintegrations of C, N, and O nuclei produced by 660 Mev protons. An analysis of the disintegrations indicates that the process involves a two-stage mechanism. The excitation energies, mean charge values \bar{Z} and mean mass numbers \bar{A} are estimated for the residual nucleus which is formed after the cascade stage of the disintegration. The angular distributions of the ejected particles are obtained. From the data obtained, an attempt is made to

estimate the mean lifetime of α -particle substructures inside light nuclei. (auth)

18843 FISSION OF ANTIMONY NUCLEI INDUCED BY HIGH ENERGY PROTONS. A. L. Lavrukina, E. E. Rakovskii, Hung-kuei Su, and S. Khoznatskii (Inst. of Geochemistry and Analytical Chemistry, Academy of Sciences, USSR). *Zhur. Eksptl'. i Teoret. Fiz.*, 40: 409-18 (Feb. 1961). (In Russian)

Fission of antimony nuclei produced by 660 Mev protons was studied. The yields as functions of A and Z are described by single-humped curves. Isotopes lying near the nuclear stability line are produced with the highest probability. Fission is mainly of a symmetric nature and involves the emission of a large number of charged particles. At $E_p = 660$ Mev the total fission cross section is 0.25 mb. The contribution from neutron deficient isotopes is relatively higher in fissioning antimony nuclei than in heavy nuclei. The contribution from asymmetric fissions decreases with decrease of the incident proton energy. The main characteristics of fission of nuclei induced by fast protons are shown to vary in a regular manner with decrease of z of the target. (auth)

18844 INVESTIGATION OF THE RADIATIONS FROM Zn^{65} . S. S. Vasil'ev, No Song Ch'ang, and L. Ya. Shavtvalov (Moscow State Univ.). *Zhur. Eksptl'. i Teoret. Fiz.*, 40: 475-6 (Feb. 1961). (In Russian)

The β^+ and γ -spectra of Zn^{65} which possesses a half-life of 37.6 ± 0.3 min. were investigated. The β^+ -spectrum consists of 5 components with end point energies of 500, 1020, 1400, 1710, and 2360 keV. The 680, 970, 1350, 1430, and 2300 keV γ -transitions which were observed, as a whole agree with the β^+ -spectra. (auth)

18845 ELASTIC SCATTERING OF 13.6 MeV DEUTERONS BY NUCLEI. [PART] II. Yu. V. Gofman and O. F. Nemets. *Zhur. Eksptl'. i Teoret. Fiz.*, 40: 477-8 (Feb. 1961). (In Russian)

The angular distributions of 13.6-Mev deuterons elastically scattered on U, Bi, Cd, Zr, Nb, Zn, Ti, Si, Al, and C nuclei are measured. (auth)

18846 ON THE 892.4 keV γ -TRANSITION IN W^{182} . V. D. Vitman, N. A. Voinova, B. S. Dzhelepov, and A. A. Karan (All-Union Inst. of Metrology, USSR). *Zhur. Eksptl'. i Teoret. Fiz.*, 40: 479-82 (Feb. 1961). (In Russian)

Results of measurement of the relative intensities of γ -transitions from the 1221.8 keV level in W^{182} to levels of the ground rotational band are presented. The intensity of the $h\nu = 892.4$ keV transition is found to be smaller than that computed by the theory for axial nuclei as well as the theory for nonaxial nuclei. (auth)

18847 NEUTRON POLARIZATION IN THE DISINTEGRATION OF Be^9 NUCLEI BY CIRCULARLY POLARIZED γ -QUANTA. I. Sh. Vashakidze, T. I. Kopaleishvili, and G. A. Chilashvili (Inst. of Physics, Academy of Sciences, Georgian SSR). *Zhur. Eksptl'. i Teoret. Fiz.*, 40: 491-2 (Feb. 1961). (In Russian)

The polarization of photon neutrons emitted in the reaction $Be^9(\gamma, n)Be^8$ is determined for circularly polarized γ -quanta. It is shown that for certain neutron emission angles the polarization is as high as $\sim 50\%$. (auth)

18848 ASYMPTOTIC BEHAVIOR OF THE SCATTERING AMPLITUDE AT INFINITE ENERGIES. L. A. Khalifin. *Zhur. Eksptl'. i Teoret. Fiz.*, 40: 493-7 (Feb. 1961). (In Russian)

The behavior of the scattering amplitude at infinite energies is investigated on the basis of the unitarity condition. The relation between the asymptotic behavior of the forward

scattering amplitude and the derivatives of the differential cross sections for elastic scattering with respect to the angle is established. (auth)

18849 DOUBLE DISPERSION RELATIONS FOR POTENTIAL SCATTERING. V. I. Mal'chenko (Dnepropetrovsk State Univ., USSR). Zhur. Eksptl'. i Teoret. Fiz., 40: 546-8(Feb. 1961). (In Russian)

The analytic properties of the potential scattering matrix $T(k^2, t)$ as a function of t are studied for real values of k^2 , where k^2 is the square of the momentum and t is the square of the momentum transfer. Potentials of the form $F(r)e^{-\alpha r}/r$ are considered. (auth)

18850 ON THE MECHANISM OF PHOTONUCLEAR REACTIONS. A. M. Badalyan and A. I. Baz. Zhur. Eksptl'. i Teoret. Fiz., 40: 549-52(Feb. 1961). (In Russian)

A number of empirical laws cannot be explained by the statistical mechanism of photonuclear reactions if the γ -quantum energy is ≈ 10 Mev. The facts can be explained only by assuming that a few single particle states of the target nuclei significantly contribute to the cross section of the photoreaction. The nature of these states is discussed. (auth)

18851 BREMSSTRAHLUNG FROM A LONGITUDINALLY POLARIZED ELECTRON WITH ACCOUNT OF THE FINITE SIZE OF THE NUCLEUS. B. K. Kerimov and F. S. Sadykhov (Moscow State Univ.). Zhur. Eksptl'. i Teoret. Fiz., 40: 553-60(Feb. 1961). (In Russian)

The effect of the finite size of the nucleus on the angular distribution of circularly polarized bremsstrahlung radiation emitted by a longitudinally polarized high energy electron is considered. An expression for the angular distribution of external bremsstrahlung is derived by taking into account the mean square radius of the nuclear charge distribution and also the longitudinal spin correlation between the initial electron state and emitted γ -quantum. A formula is deduced which describes the effect of the finite nuclear size on the angular dependence of the degree of circular polarization of the bremsstrahlung. (auth)

18852 ON THE DOPPLER EMISSION AND ABSORPTION LINE WIDTH. M. I. Podgoretskii and A. V. Stepanov (Joint Inst. for Nuclear Research, Dubna, USSR and Lebedev Inst. of Physics, Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz., 40: 561-6(Feb. 1961). (In Russian)

A classical and quantum mechanical investigation of the influence of the Doppler effect on the line shape is carried out. The possibility of experimental observation of resonance absorption of γ -rays in liquids is considered. (auth)

18853 DISPERSION FORMULAS WHICH TAKE INTO ACCOUNT OPTICAL INTERACTION. V. I. Serdobol'skii (Lebedev Inst. of Physics, Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz., 40: 590-6(Feb. 1961). (In Russian)

A formal theory of nuclear reactions is developed which is more adequate for treating nuclear problems than the Wigner R-matrix theory. For mathematical separation of compound nuclear resonances, the approximate orthogonality between the wave functions of the compound nucleus and ground unexcited state functions is exploited. The theoretical treatment is developed to an extent sufficient for obtaining concrete dispersion formulas which take into account mutually overlapping levels and the interaction between particles and the optical potential of the nucleus. (auth)

18854 ON THE RELATION BETWEEN THE PARTIAL AMPLITUDES AND SPECTRAL FUNCTION EQUATIONS.

Yu. A. Simonov. Zhur. Eksptl'. i Teoret. Fiz., 40: 626-9(Feb. 1961). (In Russian)

It is shown how the Chew-Mandelstam partial amplitude equations can be deduced from the equations for spectral functions in the Mandelstam representation. (auth)

18855 ANTIPROTONIUM LEVEL SHIFTS FOR LARGE ORBITAL ANGULAR MOMENTA. A. F. Grashin. Zhur. Eksptl'. i Teoret. Fiz., 40: 652-3(Feb. 1961). (In Russian)

Level shifts in a proton-antiproton system due to single-meson interaction are calculated. (auth)

18856 AN INVESTIGATION OF THE PROPERTIES OF TRANSURANIUM ELEMENTS BASED ON THE SUPERFLUID MODEL OF THE NUCLEUS. V. G. Solov'ev (Joint Inst. for Nuclear Research, Dubna, USSR). Zhur. Eksptl'. i Teoret. Fiz., 40: 654-65(Feb. 1961). (In Russian)

The properties of strongly deformed transuranium elements are investigated on the basis of the superfluid model of the nucleus. Some insignificant modifications are introduced in Nilsson's schemes by employing the experimental data and taking into account the effect of superfluidity. The pairing energies are computed and the following values for the coupling constants have been obtained: $G_N = 0.020\hbar\omega_0$, $G_p = 0.022\hbar\omega_0$. Single-particle excitation spectra are calculated for odd mass nuclei, the calculated level density being about twice as large as that predicted by the Nilsson scheme. Single-particle excitations in even-even nuclei are computed, and in all calculated spectra for even-even nuclei (Th^{232} , U^{234} , Pu^{238} , Pu^{240} , Pu^{242} , Cm^{246} , and Cf^{248}) the lowest levels were found to be the 1^- levels which lie below 1 Mev. Corrections to β - and γ -transitions due to superfluidity of the ground and excited states are computed. The results obtained are self-consistent: correct values for pair energies and levels of even and odd nuclei are obtained for the same values of G , whereas variation of G by 30-40% leads to a pronounced deviation from the experimental data. (auth)

18857 ON THE PROBLEM OF CALCULATING THE MOMENTS OF INERTIA OF NUCLEI. S. T. Belyaev. Zhur. Eksptl'. i Teoret. Fiz., 40: 672-5(Feb. 1961). (In Russian)

An expression for the moment of inertia of nuclei in which nucleon pairing is taken into account is derived by applying the generalized canonical transformation method. As a whole, the result is identical to that previously obtained by Migdal with help of the Green's function method. (auth)

18858 SINGLE PARTICLE EXCITATIONS AND SUPERFLUIDITY IN SYSTEMS CONSISTING OF FERMI PARTICLES WITH AN ARBITRARY INTERACTION APPLICATION TO THE NUCLEUS. A. B. Migdal (Moscow Engineering Physics Inst.). Zhur. Eksptl'. i Teoret. Fiz., 40: 684-97(Feb. 1961). (In Russian)

An equation set describing single particle excitations for excitation energies which are small compared with the chemical potential of the system can be obtained by investigating the analytical properties of the Green's functions and taking into account pair correlation. The equations are valid for an arbitrary interaction law. Equations are derived which describe the excited states of a system with a finite number of particles with an accuracy to terms of the order of $N^{-1/4}$. It is indicated how the results can be applied to real nuclei. (auth)

18859 TRANSITIONS BETWEEN HYPERFINE STRUCTURE LEVELS IN DEUTERIUM MESIC ATOMS. S. S. Gershtein (Joint Inst. for Nuclear Research, Dubna, USSR). Zhur. Eksptl'. i Teoret. Fiz., 40: 698-707(Feb. 1961). (In Russian)

The effective cross section for transition of $d\mu$ mesic

atoms to the hyperfine structure ground state ($F = 1/2$) due to exchange collisions with the deuterons is calculated. It is shown that practically complete depolarization of the μ -mesons should be observed in pure deuterium. It is pointed out that the transition of $d\mu$ to the $F = 1/2$ state increases the probability of the capture process $\mu^- + d \rightarrow 2n + \nu$ (by three times in the case of $V-A$ coupling). The effect of the transition to the $F = 1/2$ state on catalysis of the $p + d \rightarrow \text{He}_3$ reaction is examined. (auth)

8860 CIRCULAR POLARIZATION OF γ -QUANTA IN THE $\text{B}^{10}(\text{d}, \text{py})\text{B}^{11}$ REACTION. J. Zimányi, J. Erő, L. Pocs, and I. Szentpéteri (Central Research Inst. of Physics, Hungarian Academy of Sciences). Zhur. Eksptl'. i Teoret. Fiz., 40: 709-11 (Feb. 1961). (In Russian)

The circular polarization of 2.14-Mev γ -quanta was determined from the first excited state of B^{11} in the $\text{B}^{10}(\text{d}, \text{py})\text{B}^{11}$ reaction, bombarding a thick layer of B enriched to 90% in B^{10} . The experimental arrangement included the detection of protons and γ quanta emitted under an angle of 90° with respect to the neutron beam, using the same azimuthal angle between the 2 detectors. The polarization was found to be $P_\gamma = (37 \pm 19)\%$, designating the sign of $n = [k_z k_p]$ as positive. The first excited state has a spin of $I = 1/2$ while the correlation between circular polarization and the polarization of the last nucleus is $P_f = -2P_\gamma$. (TTT)

18861 ENERGY SHIFTS IN γ -TRANSITIONS OBSERVED BY RESONANCE ABSORPTION OF γ -QUANTA IN CRYSTALS. V. A. Bryukhanov, N. N. Delyagin, B. Zvenglinskiĭ, and V. S. Shpinel (Moscow State Univ.). Zhur. Eksptl'. i Teoret. Fiz., 40: 713-14 (Feb. 1961). (In Russian)

The absorption spectra of various crystalline compounds containing a natural isotopic mixture of Sn were determined at the liquid nitrogen temperature, using a $\text{Sn}^{119\text{m}}$ (white metallic tin) source. The spectra obtained had a doublet structure, presenting an energy shift in the absorption lines in the negative energy side for SnO_2 and in the positive side for SnCl_2 with reference to the absorption energy of SnI_4 . This is due to the interaction of nuclei with electrons with a wave function other than 0 at the states between which the γ -transition takes place. Calculation of these shifts may supply additional information on the charge distribution in the nucleus. (TTT)

18862 THE ENERGY DEPENDENCE OF SCATTERING CROSS SECTION AT LOW ENERGIES. S. M. Bilen'kiĭ (Joint Inst. for Nuclear Research, Dubna, USSR). Zhur. Eksptl'. i Teoret. Fiz., 40: 714-15 (Feb. 1961). (In Russian)

It is shown that the first two members of the decomposition according to k of the elastic scattering cross section takes the shape of $\sigma = \sigma_0 (1 - 1/2\pi k(\sigma_0 k_0 + \dots)$, i.e., the scattering cross section is determined by $(\sigma_n k_0)$ and by the value σ_0 of the scattering cross section at $k = 0$. In the case of elastic scattering alone, we have: $\sigma = \sigma_0 + k^2 \sigma_1 + \dots$. For inelastic events, the linear member of the expression must be also taken into consideration. The first equation is valid in cases in which at least one of the particles does not have spin in its ground state. It may be used to extrapolate to 0 the $\pi^- p$ cross section and the $\bar{K} p$ scattering. (TTT)

18863 HIGH-ENERGY ELECTRON SCATTERING TABLES. Robert Herman and Robert Hofstadter. Stanford, California, Stanford University Press, 1960. 285p.

A handbook of high-energy electron-scattering cross section information is presented. Tables of nuclear charge

densities and form factors, using Gaussian, exponential, Yukawa, harmonic well, Clementel-Villi, uniform, and shell models are given. Data are given for electron-electron, electron-deuteron, and electron-nucleon interactions. The Born approximation is discussed. The energy of the scattered electron, the use of heavier projectiles than electrons, kinematic relations, and muon scattering are reviewed. (T.F.H.)

Particle Accelerators

18864 (BNL-5349) A DIGITAL DATA HANDLER FOR PULSED PARTICLE ACCELERATORS. W. A. Higinbotham and D. W. Potter (Brookhaven National Lab., Upton, N. Y.). [nd]. 11p.

A digital data handler is described for storing information in a magnetic core memory during the pulse of a synchrotron and transferring it to a slow memory during the dead time. Digital measurements of trajectory, pulse height, time of flight, and run number are typical data. The magnetic core memory provides capacity for storing 32 words (events) of 96 bits during a burst. The information contained in the core memory is then transferred to one-inch magnetic tape during the dead time of the accelerator. Thence the information may be fed to a computer for future study. For economy, the data handler has one buffer which serves as the input, output and shift register. (auth)

18865 (BNL-5420) AGS HIGH LEVEL RF AUTOMATIC GAIN CONTROL AND AMPLITUDE PROGRAMS. H. J. Halama (Brookhaven National Lab., Upton, N. Y.). Mar. 14, 1961. 4p.

The amplitude of r-f voltage across the cavities is held constant and controlled by a signal derived from one cavity. Three different programs operating on the r-f amplitude are used. The three program generators are described and a block diagram of the system with associated programs is included. (J.R.D.)

18866 (BNL-5421) STARTING OSCILLATOR AND ITS PROGRAM. Internal Report. H. J. Halama (Brookhaven National Lab., Upton, N. Y.). Mar. 29, 1961. Contract AT(30-2)-Gen-16. 16p.

The accelerator starting oscillator's function in stabilizing the r-f system before the proton beam is injected and its function in bunching the beam according to the harmonic order of the r-f voltage are described. (J.R.D.)

18867 (BNL-5423) SOME PROBLEMS INVOLVED IN THE USE OF A 1000-Bev ACCELERATOR. A. Galonsky (Brookhaven National Lab., Upton, N. Y.). Jan. 27, 1961. 5p.

The problems related to induced radioactivity in the tunnels of high-energy accelerators are considered. Calculations indicated that in 1000-Bev accelerators the radioactivity especially around the target will be much above tolerance. Methods of minimizing maintenance and the use of remote handling equipment are discussed. Other discussions are presented on beam extraction and vacuum requirements. (J.R.D.)

18868 (BNL-5425) VACUUM SYSTEM FOR A 1000-Bev ACCELERATOR. C. L. Gould (Brookhaven National Lab., Upton, N. Y.). Feb. 14, 1961. 3p.

Parameters of outgassing and vacuum maintenance are analyzed. It was thought that cryogenic pumping and getter-ion pumping would be necessary to achieve desired pressures in the accelerating tube. Use of a manifold to eliminate poor vacuum chamber conductance is also recommended for consideration. (J.R.D.)

18869 (BNL-5426) LINEAR ACCELERATOR THEORY. J. P. Blewett (Brookhaven National Lab., Upton, N. Y.). May 20, 1953. 8p.

Linear accelerator theory is presented in a useful form and is extended to the relativistic range. Solutions of equations for phase oscillations and radial defocusing forces are included. (J.R.D.)

18870 (BNL-5427) SCALING CALCULATIONS FOR A 1000-Bev ACCELERATOR. F. T. Cole (Brookhaven National Lab., Upton, N. Y.). Jan. 25, 1961. 5p.

The calculations of the Berkeley Accelerator Planning Group released in report IS-2 were extended to a 1000 Bev accelerator. Values of the magnet parameter $l_0 = [B/(db)/(dr)]$ were investigated from 4 to 10 in. and at injection energies of 10 to 20 Bev. Orbit and magnet parameters are tabulated along with other data. (J.R.D.)

18871 (BNL-5428) RF PARAMETERS OF THE AGS INJECTOR. J. D. Kiesling (Brookhaven National Lab., Upton, N. Y.). Mar. 29, 1957. 9p. (ADD-JDK-1).

Calculations are presented which indicate that the total losses for the AGS injector including ball tuners should be less than 2.5 megawatts with a stored energy of 121 joules, giving a Q value of 70,000 (for 2.2 megawatts). In the final accelerator assembly, the tanks of the linac injector are to be assembled and tested as individual sections. Substantial deviations from calculated Q values are taken as indications of construction errors. (J.R.D.)

18872 (BNL-5429) ALIGNMENT OF THE MAGNETIC CENTERS OF QUADRUPOLE FOCUSING MAGNETS IN A LINEAR ACCELERATOR. J. G. Cottingham (Brookhaven National Lab., Upton, N. Y.). Apr. 27, 1956. 6p. (ADD-JGC-7).

Methods for alignment of magnets in linear accelerators are examined. One method consists of passing a proton beam through a lens and observing the deflection produced, moving the lens a calculated amount, and repeating until there is no deflection. Optical factors in this method are discussed along with target shape, the effects of the Earth's magnetic field and results of an alignment confirmation experiment. (J.R.D.)

18873 (BNL-5430) APPLICATION OF THE LINEAR ACCELERATOR FOR PRODUCTION OF INTENSE PROTON BEAMS AT 10 BEV. J. P. Blewett (Brookhaven National Lab., Upton, N. Y.). Dec. 31, 1956. Contract AT(30-2)-Gen-16. 11p. (ADD-JPB-7).

The use of proton linear accelerators to produce beams at 10 Bev with intensities of 30 microamperes is explored. Parameters for such machines are discussed along with buildings and shielding, and economic factors. (J.R.D.)

18874 (BNL-5431) COMPARISON OF PHASE OSCILLATIONS IN LINAC, FIXED-FIELD CIRCULAR ACCELERATOR, AND SYNCHROTRON. Lee C. Teng (Brookhaven National Lab., Upton, N. Y.). Mar. 2, 1961. Contract AT(30-2)-Gen-16. 9p.

A study is presented of the phase oscillations in drift tube and traveling wave linacs, fixed field circular accelerators, and synchrotrons. Unified notation and method development are used to exhibit the oscillation similarities and differences. (J.R.D.)

18875 (BNL-5432) KINEMATIC CALCULATIONS FOR 300-Bev ACCELERATOR. S. J. Lindenbaum and R. M. Sternheimer (Brookhaven National Lab., Upton, N. Y.). Nov. 16, 1960. 18p.

Kinematic calculations were carried out for the secondary particles produced by a 300-Bev proton accelerator. Results are presented graphically. (J.R.D.)

18876 (BNL-5433) CALCULATIONS OF LINAC PHASE OSCILLATIONS. V. E. Bach and E. D. Courant (Brookhaven National Lab., Upton, N. Y.). Oct. 7, 1953. 10p.

A proposed linear accelerator is described whose beam energy spread is not more than a few tenths of a per cent. Such an accelerator would provide a beam which is usable as an injector for alternating-gradient synchrotrons. The particles are accelerated from low energy in many stages with comparatively low energy per stage. Calculated data on energy oscillations at the drift tubes are included. (J.R.D.)

18877 (BNL-5434) COSMOTRON INJECTION-PROGRESS AND PROBLEMS. C. M. Turner (Brookhaven National Lab., Upton, N. Y.). Mar. 31, 1958. 31p.

Progress was realized during the past year toward solution of the problems involved in the production and focusing of 3.6-Mev proton beams at 10 to 50 milliamperes. In this intensity range space charge forces become the dominant consideration throughout the entire trajectory of the beam, — first, at the point of extraction of ions from the plasma in which they are produced, second, through the acceleration tube of the Van de Graaff accelerator, and third, in the field free drift space between Van de Graaff and Cosmotron. Experience has shown that the PIG (or Penning) type ion source is capable of proton currents at 50 to 100 milliamperes, and very likely substantially more, with approximately 75% of the total output consisting of protons. The problem of overcoming the deleterious effect of space charge during the relatively long flight time through the acceleration tube appears to have been effectively solved by the technique of compressing the beam against its space charge forces during acceleration. Recent observations suggest that the resulting increase of intensity and area density of the beam emerging from the acceleration tube have brought up a new problem in the field free drift space between Van de Graaff and Cosmotron, — a region which has heretofore been taken pretty much for granted. Although the beam intensities are in the range where the normal negative lens characteristic of space charge begins to play an important role, observations indicate that in the vicinity of a crossover an unexpected and highly aberrant effect occurs and largely destroys the desirable focal properties of the beam. It presently appears that it is a consequence of a highly non-uniform neutralization of the space charge within the beam cross section by the electrons liberated in ionizing encounters between ions in the beam and molecules of residual gas. (auth)

18878 (BNL-5435) SOME COMMENTS UPON THE INFLUENCE OF SPACE CHARGE IN BETATRON OSCILLATIONS. M. Tigner (Brookhaven National Lab., Upton, N. Y.). Aug. 19, 1959. 14p.

The equations of motion of a proton beam under the influence of its self-field are studied and it is found that the space charge has a pronounced effect on both the frequency and amplitude of oscillation. (auth)

18879 (BNL-5436) SPACE CHARGE EFFECTS IN THE COSMOTRON INJECTION SYSTEM. M. Tigner (Brookhaven National Lab., Upton, N. Y.). Aug. 13, 1959. 21p.

The effect of space charge on the equations of motion in the injection system is studied and it is shown that while the effects in individual lens elements are essentially negligible with parameters encountered in practice, the effects in the drift spaces are quite important. (auth)

18880 (DESY-A2.73) ZUR ENTWICKLUNG DER QUADRUPOLLINSEN. (On the Expansion of the Quadrupole

Lens). Hans Hultschig (Deutsches Elektronen-Synchrotron, Hamburg). Dec. 20, 1960. 12p.

Three lens shapes derived from the Panofsky lens, which yield theoretically an exact quadrupole field, permit a rectangular cross section, and are comparable costwise with the classical lens, are examined. All these lenses are linear. (J.S.R.)

18881 (IFA-A-20) ON THE NATURAL PULSING OF THE CYCLOTRON EXTERNAL BEAM IN THE NANOSCOND RANGE. F. Tinta, N. Martalogu, R. Dumitrescu, and T. Magda (Academia R. P. R. Institutul de Fizica Atomica, Bucharest). 1961. 27p.

A theoretical study of dynamic processes within the cyclotron leading to pulsing of the ion beam is presented. The main factors determining the shape and duration of natural pulsing of the beams were studied experimentally. It was found that the form and duration of cyclotron natural pulses depend on special working conditions, e.g., compensatory coils of the median plane and azimuthal shims, and are not uniquely determined by parameters such as dee gap width, r-f voltage, and resonant frequency. Shorter pulses can be obtained with higher r-f voltages, contrary to expectation. The implications of the results are discussed. (D.L.C.)

18882 (INS-27) THE DESIGN STUDY AND THE GENERAL PICTURE OF THE LINEAR ELECTRON ACCELERATOR FOR THE INJECTOR OF 1 BeV SYNCHROTRON. Tetsuji Nishikawa, Jiro Tanaka, Akira Miyahara, and Hiroo Kumagai (Tokyo Univ. Inst. for Nuclear Study). [1959?]. 26p.

The design of a linear electron accelerator to be used as injector for a strong focusing synchrotron is described. The spread of the output energy was found to be caused by the different phase motions of the electrons injected at various phase angles and by variations in microwave power, frequency, and other parameters. These two effects were suppressed by careful design, especially on the buncher, and by the use of a prebuncher and a stable power system. An output energy spread of only a few percent was obtained at an energy of 6.5 Mev. (auth)

18883 (INS-TH-38) TEST CAVITY—INS LINEAR ELECTRON ACCELERATOR. (Tokyo Univ. Inst. for Nuclear Study). Mar. 27, 1961. 24p.

The correction of the accelerator guide dimension of the INS 6-Mev linear electron accelerator is described. The dimensions of the accelerator guide were calculated by the theoretical design and corrected experimentally by the microwave measurements on the test cavities. It was found that the resonant frequency of the accelerator guide depends largely on the contour forming of the disk hole. (auth)

18884 (NP-10073) BERICHT ZUR GRÜNDUNG DER STIFTUNG DESY. (Report on the Foundation of DESY). (Deutsches Elektronen-Synchrotron, Hamburg). Dec. 18, 1959. 104p.

Reports presented to the Scientific Council on the design and purposes of DESY are given. The topics discussed are the construction design, characteristic problems of the electron synchrotron, the injection of the electron beam, the synchrotron magnet, the high-frequency acceleration system, energy supply, and operation and control. Experimental installations and examples are reviewed. The organization of the DESY Foundation is given. (J.S.R.)

18885 (TID-12587) ELECTRON BUNCHING BY UNIFORM SECTIONS OF DISK-LOADED WAVEGUIDE. PART A. GENERAL STUDY. Georges Dôme (Stanford Univ., Calif. W. W. Hansen Labs. of Physics). Dec. 1960. Contract AT(04-3)-21. 82p. (ML-780-A; M-242-A)

A study was made of the properties of a uniform waveguide section, where the electric-field strength and the phase velocity of the traveling wave are constant along the axis. It appears that if the phase velocity of the wave in the waveguide section is equal to the injection velocity of the unmodulated electrons, the waveguide section can function effectively as a prebuncher and would not require more than 100 watts of r-f power. The buncher is compared with a velocity-modulating cavity followed by a drift space. It is shown that it can achieve better bunching than is obtained by velocity modulation, and is also less sensitive to small fluctuations of the r-f power level. (auth)

18886 A 150 kV ION ACCELERATOR. M. Mangialajo, P. Principi, F. Tonolini (CISE, [Milan]). *Energia nucleare* (Milan), 8: 237-42 (Apr. 1961). (In Italian)

A 150 kv accelerator for atomic and molecular ion beams is designed and built in CISE's Nuclear Physics Laboratory. Besides being simple in construction and functioning, it offers the possibility of obtaining currents of the order of a ma. The radiofrequency ion source with axial magnetic field permits extraction of a current of 2 ma. The machine can be employed as an ion injector for plasma physics research and for studies of elementary collision phenomena in atomic physics. The accelerator may conveniently be used as a 14 Mev neutron generator, by means of the reaction $T(d,n) He^4$, allowing intensities of 10^9 to 10^{10} neutrons/sec to be obtained. (auth)

18887 A PROPOSAL FOR INCREASING THE BEAM OUTPUT FROM A SYNCHROCYCLOTRON. F. M. Russell (National Inst. for Research in Nuclear Science, Harwell, Berks, Eng.). *Nature*, 190: 335 (Apr. 22, 1961).

A scheme is presented for increasing the beam output from a synchrocyclotron by placing a small dee system, covering the orbits of ions with energies of up to about 5 Mev, opposite the live dee at the center of the machine. A high-voltage radiofrequency signal is fed to the small additional dee which is in antiphase to that on the main dee. This system is derived from the main oscillator system after amplification in a separate power amplifier. The auxiliary amplifier is pulsed on at a time slightly before the main dee commences to capture ions from the ion source, and is switched off when the captured ions have gained on the average a few Mev. Results are reported from preliminary tests made with the Harwell 110-in. synchrocyclotron, using an 11-in. radius dee with a total operating time of approximately 50 μ sec in each main modulating cycle. (C.H.)

18888 A METHOD FOR EXPANDING THE PHASE-STABLE REGIME IN SYNCHRONOUS ACCELERATORS. L. L. Foldy (Case Inst. of Tech., Cleveland). *Nuovo cimento* (10), 19: 1116-20 (Mar. 16, 1961). (In English)

Possible advantages resulting from the use of non-sinusoidal radiofrequency accelerating potentials in synchronous accelerators are pointed out and discussed. It is possible to extend the regime of phase stability and to overcome space charge effects. (auth)

18889 NEGATIVE OXYGEN IONS FROM A GLOW DISCHARGE SOURCE. W. S. Whitlock and J. E. Bouden (Services Electronics Lab., Baldock, Herts, Eng.). *Proc. Phys. Soc. (London)*, 77: 845-52 (Apr. 1, 1961).

A simple source of O^- ions suitable for accelerator applications is described. Negative atomic ion currents of over 2 μ amp can be directly extracted at 10 kev for a low-pressure cold-cathode oxygen discharge source that incorporates an electrostatic constrictor electrode. The input power is only 25 watts and the gas consumption $14 cm^3 h^{-1}$ of oxygen at atmospheric pressure. Mass analysis

of the beam shows the primary components to be O^+ and O_2^+ ions; the main impurity ions are OH^+ , Cl^+ and NO_2^+ . A study is made of the relationship between the negative ion yield and various source operating conditions. The O^- and O_2^- ion yields are shown to be related to the striated structure of the positive column. With a singly striated column the beam is composed mainly of atomic ions. Only when a doubly striated column is formed does the O_2^- yield become large. Ion production processes are discussed in terms of this relationship. (auth)

18890 ABOUT THE BEHAVIOR OF THE ELECTRON BEAM IN BETATRON DURING INJECTION. Yu. N. Lobanov and N. I. Tulinova. Zhur. Tekh. Fiz., 31: 194-9 (Feb. 1961). (In Russian)

The charge distribution along the cross section of an electron beam in a betatron and the distribution of beams along the chamber cross section during the first rotations following injection were studied. The obtained data are used for determining the width of the beam. (tr-auth)

18891 FREE MOVEMENT OF PARTICLES IN ACCELERATOR WITH CONSTANT FIELD AND STRONG FOCUSING. A. P. Fateev. Zhur. Tekh. Fiz., 31: 238-53 (Feb. 1961). (In Russian)

An approximation method is suggested for calculating particle trajectories in an accelerator with strong constant focusing. The derived formulas offer a fast and accurate calculational method for determining the various specifications of the installation: the magnetic field efficiency coefficient, betatron oscillation frequencies, etc. Calculations for the magnetic system of a circular radial-sector phasatron are included. (R.V.J.)

Plasma Physics and Thermonuclear Processes

18892 (AD-246927) DOWN-RANGE ANTI-BALLISTIC MEASUREMENT PROGRAM (DAMP). MICROWAVE EMISSION FROM PLASMA. I. Concepts of Equilibrium Radiation and Their Application. Research Report No. I—Microwave Radiation from Plasmas. (Radio Corp. of America. Missile and Surface Radar Div., Morrestown, N. J.). Nov. 1960. Contract DA-36-034-ORD-2549 and DA-36-034-ORD-2683. 50p.

A discussion is given of the various concepts associated with equilibrium radiation and their application to the microwave emission by plasmas. The physical concepts associated with the absorption and emission of radiation in a given medium as well as the presentation of the basic laws relating these concepts are discussed. The flow of radiation through a medium based on the general equation of radiative transfer is discussed. The possible types of equilibrium conditions encountered in radiative transfers are examined. It is shown how the elementary processes of radiation may be related to the phenomenological concepts of radiative transfer. This is done by expressing the emissivity and the absorption coefficient in terms of Einstein's coefficients for emission and absorption of radiation. Solutions of the radiative transfer equation are presented for a plasma slab in free-space and in a waveguide. The case of a cylindrical plasma in a waveguide is also treated. The solutions are given in terms of the electromagnetic properties of a uniform isotropic plasma. The exact solution for the radiation emitted by a plasma situated in a waveguide is derived using the transmission line and equivalent circuit representations of an obstacle in a waveguide. The solution is based on a general formulation of Kirchhoff's law of radiation and as

such represents a physical optics solution to the problem of equilibrium radiation. (auth)

18893 (AFOSR-358) STUDY OF HEATING AND ACCELERATION OF PLASMA BY MAGNETIC FIELDS. Final Project Report, February 1958—February 1961. Meredith C. Gouridine (Plasmadyne Corp., Santa Ana, Calif.). Mar. 1, 1961. Contract AF 49-(638)-335. 41p. (FRO21-335)

A summary is presented of investigations related to developing a means of heating, accelerating, and channeling plasma jets by magnetic fields. Included are discussions of work on transient electrodeless discharge, steady-state plasma channeling, and confinement, compression, heating and propulsion of plasma by the Punch Method. Other investigations were conducted on magnetohydrodynamic shear heating, conductivity measurements, and MHD channel flow of a rotating fluid. (J.R.D.)

18894 (AFOSR-360) COLLISION-FREE PLASMAS. Harry E. Petschek (Avco Corp. Avco-Everett Research Lab., Everett, Mass.). Nov. 1960. Contracts AF49(638)-61 and Nonr-2524(00). 12p. (AMP-52)

In the corona regions of stars the ratio of the mean free path for interparticle collision to the gyro radius becomes very large. Under these conditions the transport processes in the plasma become dominated by plasma turbulence. This phenomenon can be described in terms of a kinetic theory of a random distribution of waves. The structure of a shock wave under these conditions was considered. At densities as low as 10^{12} particles per cm^3 the thickness of such a shock wave should be very thin, less than 100 km. The effects of such a turbulent wave field on reducing the electrical conductivity were considered. It seems possible that appreciable diffusion of the magnetic field relative to the plasma could occur under some astronomical conditions. (auth)

18895 (AFOSR-479) RADIATION BY A LARGE AMPLITUDE PLASMA OSCILLATION. Technical Note BN-236. D. A. Tidman and George H. Weiss (Maryland. Univ., College Park. Inst. for Fluid Dynamics and Applied Mathematics). Mar. 1961. Contract AF18(600)1315. 10p.

Considerations are given for a plasma oscillation which is initially, purely longitudinal in a plasma of zero temperature. Second order perturbation theory is used to calculate the amount of electromagnetic radiation produced by the wave. (auth)

18896 (GEAP-3484) PLASMA AS A THERMOCOUPLE LEG. John H. Ingold and Lewi Tonks (General Electric Co. Vallecitos Atomic Lab., Pleasanton, Calif.). Dec. 31, 1960. 15p. (R60APE9)

The thermoelectric power of the plasma diode was calculated using concepts from the kinetic theory of gases. The result is independent of the electrode work functions and is in close agreement with that which was obtained for an n-type semiconductor. (auth)

18897 (LAMS-2544) QUARTERLY STATUS REPORT OF THE LASL PLASMA THERMOCOUPLE DEVELOPMENT PROGRAM FOR PERIOD ENDING MARCH 20, 1961. (Los Alamos Scientific Lab., N. Mex.). Apr. 1961. Contract W-7405-ENG-36. 15p.

In a new design of the "in-pile" plasma thermocouple cell the fuel pin-collector assembly was inverted. This facilitates the use of thermocouples for measuring the fuel pin temperatures during cell operation, and simplifies the cell assembly, particularly when the collector-outer envelope spacing is small. In the first successful test (RT-MP-4) of the modified cell (called a "trombone" type), the fuel pin consisted of $(UO_2)_{0.5}(Mo)_{0.5}$, with the uranium-235 con-

tent about one-fifth that of the pins previously used. The pin was enclosed in a niobium capsule. The collector temperature, with the Omega West Reactor operating at a power of 5 Mw, was 350°C. In a second "in-pile" test of the "trombone" cell (RT-122), the fuel pin was of the standard $(\text{UC})_{0.3}(\text{ZrC})_{0.7}$ form which has been used in many previous tests. There was no high-temperature thermocouple but the pressure transducer was included. The failure pattern in the current at the end of the test resembled that of previous tests. In cells RT-132 and RT-133 high-temperature thermocouples were incorporated into standard $(\text{UC})_{0.3}(\text{ZrC})_{0.7}$ fuel pins in order to measure the temperatures of the pins. These cells failed after a short time in the reactor. X-ray examination of cell RT-132 shows that the fuel pin had broken. In the "in-pile" experiments, the test cell was placed in the center hole of a dummy fuel element. The flux in the pin was monitored by a thermopile, in a nearby hole, and positioned vertically opposite the pin in the test device. Analysis of the data indicates that the ratio of the flux at the thermopile and test cell remains constant. Measurements were made of the transfer rate of cesium vapor and from the results the viscosity was determined. The apparatus consisted principally of a small retort containing liquid cesium which could be vaporized by electrical heating. From the data the viscosity of cesium vapor in the tube was calculated, by means of a formula based on the Hagen-Poiseuille equation, and found to be 1.75×10^{-4} poise at 700°K. A redetermination of the electron emission of UC was completed. The least-square fitted values for the parameters in Richardson's equation were $\phi = 3.3 \pm 0.1$ volts and $A = 113 \pm 33$ amp $^{\circ}\text{K}^{-2}\text{cm}^{-2}$. An x-ray diffraction analysis of the coating on the wire indicated that it was single phase uranium monocarbide. Results of a study of the vaporization of $(\text{UC})_{0.3}(\text{ZrC})_{0.7}$ indicate that the evaporating material is appreciably richer in uranium than the residue. Analyses of the residual material showed significant loss of uranium at the center of the 1 mm radius cylindrical samples. Firing tests to metallize Al_2O_3 with Cu by coating the alumina with CuO_2 and firing in H_2 have indicated 1225 to be better than 1250°C. At the lower temperature there is less fluidity of the $\text{Cu}_2\text{O}-\text{Al}_2\text{O}_3$ eutectic; this results in a more even, smoother coating. An anodic coating on Be was produced which is electrically insulating. Hard, dense, uniform oxide coats have been produced on Nb by anodic treatment in a 1% H_2SO_4 -4.5% HF solution at 25 to 40°C. A 1-mil coat can be produced in 15 min. However, these coats do not withstand Cs vapor attack, but they may find application elsewhere. (auth)

18898 (NYO-9493) SHERWOOD PROGRESS REPORT NO. 4, JULY 1959-DECEMBER 1960. H. Grad (New York Univ., New York. Inst. of Mathematical Sciences). Mar. 1, 1961. Contract AT(30-1)-1480. 25p. (MF-14)

Activities related to Project Sherwood are summarized under the following topics: propagation of waves, macroscopic magneto-fluid dynamics, stability, particle orbits, cusped geometries, collisionless shock theory, and other subjects. (D.L.C.)

18899 (ORNL-3113) ATOMIC AND MOLECULAR COLLISION CROSS SECTIONS OF INTEREST IN CONTROLLED THERMONUCLEAR RESEARCH. C. F. Barnett, W. B. Gauster, and J. A. Ray (Oak Ridge National Lab., Tenn.). May 15, 1961. Contract W-7405-eng-26. 176p.

A graphical compilation is presented of atomic and molecular cross sections of interest to controlled thermonuclear research. The cross sections are shown, as a function of energy, for collision processes involving molecular ion dissociation, charge exchange, excitation, ionization,

photoionization, scattering, energy loss, and recombination. Pertinent nuclear cross sections are also included. A bibliography is given covering the literature since 1950. (auth)

18900 (SIT-P-21) INVESTIGATION OF PLASMA ACCELERATION. Semi-Annual Progress Report No. 7, January 1, 1960-September 10, 1960, Megatron Accelerator Progress Report. K. C. Rogers, D. Finkelstein, and G. Brucker (Stevens Inst. of Tech., Hoboken, N. J.). Contract DA 36-039-SC-78097. 97p. (AD-245936)

Experimental and theoretical results on pulsed magnetic field shaping and high-voltage, high-current switching are summarized. Work on plasma betatron theory and plasma injection into the betatrons is discussed. (auth)

18901 (TID-12450) PERSISTENCE OF STABILITY IN LAGRANGIAN SYSTEMS. F. E. Low (General Atomic Div., General Dynamic Corp., San Diego, Calif. and Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). 1958. Contract AT(30-1)-2098. 17p.

It is shown for a large class of Lagrangian systems that a steady state configuration of the system which is linearly stable remains so under a small variation of the steady state, to all orders of perturbation theory in the variation. The principle is applied to the systems: an incompressible ideal fluid, and a gas of charged particles interacting through their average fields. (auth)

18902 (TID-12744) ELECTRODYNAMIC FUNDAMENTALS AND NON-RELATIVISTIC MAGNETODYNAMICS. F. W. Mezger (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Apr. 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 34p. (XDC-61-4-53)

Lecture notes for a plasma physics course at the University of Cincinnati are presented. The electrodynamic principles for charged particles and for stationary and moving media are outlined. The equations of the general non-relativistic electrodynamic fluid are given. These equations were specialized to the usual equations of magnetodynamics and the equation of motion of the magnetic induction field was studied in some detail. Energy and force relations are discussed as are applications to flow of a conducting fluid and magnetahydrodynamic waves. (auth)

18903 (TP-68) INTRODUCTION TO PLASMA PHYSICS AND CONTROLLED THERMONUCLEAR RESEARCH. W. B. Thompson (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). [1959?] 15p.

Discussions are given of the reaction rate and power production, radiation losses, critical temperature, confinement time, scaling, and fusion research in fusion and thermonuclear reactions. Plasma production devices are described as the pinch, the stellarator, and mirrors. Measurements made on plasmas include electrical and magnetic characteristics, transmission in μ -wave region, optical spectra, energetic radiation x rays and neutrons, and runaway beams. (B.O.G.)

18904 (UCRL-9588) THE POSITIVE COLUMN IN A LONGITUDINAL MAGNETIC FIELD (thesis). George A. Paulikas (California. Univ., Berkeley. Lawrence Radiation Lab.). Feb. 27, 1961. Contract W-7405-eng-48. 98p.

The positive column of a glow discharge is shown to become hydromagnetically unstable when immersed in a longitudinal magnetic field of the order of 1 kilogauss. The instability transforms the azimuthally symmetric column into a constricted, rotating, helical state; neither this new steady state nor its properties are predicted by classical

theories. The critical magnetic field, B_c , describing the onset of the instability, varies approximately inversely as the tube radius and directly as the square root of the ion mass; e.g., in a helium discharge at a pressure of 1 mm Hg and in a 0.9-cm-radius tube we find $B_c = 2.4$ kilogauss. For $B > B_c$ the longitudinal electric field increases with magnetic field and indicates particle losses in excess of classical predictions. The occurrence of this instability explains the previously mysterious anomalous diffusion observed by Lehnert. The properties of the helical state were measured in H_2 , D_2 , He, and Ne as functions of gas pressure and tube radius. For this example the angular frequency of rotation of the luminous spiral is $0.8 \times 10^6 \text{ sec}^{-1}$ with a wave length of about 40 cm. Frequency decreases with increasing pressure, increasing tube radius, and increasing ion mass. The wave length is found to decrease with increasing pressure. These dependences, as well as the values of B_c are in good agreement with predictions of the perturbation theory of Kadomtsev and Nedospasov. The onset of instability as predicted by the entirely different sheath-instability theory of Hoh is not in as good agreement with the experimental results; Hoh's theory does not include a description of the nature or build-up of the presumed instability. A comparison of measurements of radial potential distributions with the theory of Ecker indicates the absence of anomalous effects for $B < B_c$. (auth)

18905 INDUCTION-COUPLED PLASMA TORCH.

Thomas B. Reed (Massachusetts Inst. of Tech., Lexington). *J. Appl. Phys.*, 32: 821-4 (May 1961).

A method of generating a stable plasma at atmospheric pressure using inductive coupling at a frequency of several Mc is described. Methods of starting and operating this plasma in argon and in mixtures of argon with helium, hydrogen, oxygen, and air are discussed. The Fowler and Milne method is used to measure the temperature profile of the plasma under various conditions of gas flow and composition, and at several power levels. Peak temperatures range from 14,000 to 19,000°K. The power losses from the plasma in the form of convection, radiation, and conduction to the nozzle walls are measured. Total power transferred to the plasma ranges from 1.6 to 3.1 kw, which is approximately 50% of the input power. The extent to which local thermal equilibrium prevails in the plasma is discussed; evidence indicates that under the operating conditions described, equilibrium is closely approached. (auth)

18906 CONTROLLED FUSION REACTIONS. P. M. S. Blackett (London Univ.). *J. Brit. Nuclear Energy Conf.*, 6: 138-50 (Apr. 1961).

A plasma physics review is given for controlled fusion reactions. Also, devices used in fusion studies are described, i.e., dynamic and semi-static self-pinched plasma devices, magnetic compression devices, and ionic injection into a static magnetic bottle. (N.W.R.)

18907 THE BEHAVIOUR OF A PLASMA UNDER THE INFLUENCE OF A STANDING ELECTROMAGNETIC WAVE IN THE ABSENCE OF A CONSTANT MAGNETIC FIELD. J. W. Gallop, T. L. Dutt, and H. Gibson (English Electric Co. Limited, Stafford, Eng.). *J. Electronics and Control*, (1) 10: 207-40 (Mar. 1961).

The physics of radial confinement of an ionized plasma in an electromagnetic field is examined for a cylindrical cavity excited in the TM_{010} and TE_{011} modes. This analysis reveals that two confining forces are operating; these forces are termed the electromagnetic force and the Mathieu force, since the equation of electron motion is a Mathieu equation. Equations giving the degree of confinement of a fully ionized plasma, and its dependence on

input power, are derived. Two types of unstable solution to Mathieu's equation are shown to arise; one of these gives rise to an exponentially increasing amplitude of oscillation. This latter solution may represent an additional mechanism of plasma heating, provided there are sufficient electron-ion collisions to dissipate an appreciable fraction of the energy of ordered motion of the electron into random motion. (auth)

18908 CONFINING A PLASMA IN STEADY ELECTRIC AND MAGNETIC FIELDS. K. A. George (Tata Inst. of Fundamental Research, Bombay). *Nature*, 190: 334 (Apr. 22, 1961).

Preliminary results are reported from experimental work on plasma containment by steady electric and magnetic fields. The required potential-well for trapping ions was provided by a cathode ring situated between two anode plates, with a magnetic field parallel to the axis of the cathode. The ions were generated by auxiliary discharges in regions adjacent to, but different from, the trapping region and drawn into the latter region. Deuterium was used in the experiments and the neutrons emitted by d-d reactions served as an indicator. The experiments were carried out at a gas pressure of a few microns of Hg, the voltage used varied from 10 to 20 kv, the discharge current was 5 to 10 m amp, and the magnetic field available was 1700 gauss. There was evidence of the confinement of the ions. The emission of neutrons indicated that high-energy ions were produced in the discharge and the neutrons were determined to be mainly from the discharge region and not from the electrodes. (C.H.)

18909 A DIRECT DIMENSIONAL ANALYSIS OF MAGNETOFLUIDDYNAMICS. A. M. Pratelli (Istituto di Matematica del Politecnico, Milan). *Nuovo cimento* (10), 903-22 (Mar. 1, 1961). (In Italian)

A dimensional analysis, without use of all the equations of magnetofluidynamics (m.f.d.), yields the generalized shape factors or parameters λ_i (ratios between two equidimensional quantities only) and the characteristic dimensionless products π_i (or ratios or numbers or invariants) of m.f.d. In the macroscopic approach (in conformity with the statement that a dimensional analysis is more successful for a greater number of fundamental independent quantities), six quantities are chosen as fundamental: length, velocity, material density, absolute temperature, magnetic induction, and the universal constant c' of the Maxwell equations. Eighteen products π_i , including the classical products of fluid mechanics, the products already employed in the m.f.d. (the magnetic Reynolds number, the Alfvén number, etc.), and also other independent products. The physical meaning of such products is illustrated, showing how particular values of c' correspond to numbers obtained in the field of particular measure-systems: if $c' = c$ (where c is the velocity of light in vacuum) the numbers are given in the gaussian system; if $c' = 1$ the numbers are given in the e.s.u. or e.m.u. or Giorgi system. The products are also employed to verify and generalize the Kihara law of similitude. (auth)

18910 PLASMA INJECTION INTO A VACUUM MAGNETIC FIELD. F. R. Scott and H. G. Voorhies (General Atomic Div., General Dynamics Corp., San Diego, Calif.). *Phys. Fluids*, 4: 600-6 (May 1961). (GA-1849)

Measurements are made on the axial injection of dense, highly directed plasmas of deuterium, hydrogen, and helium into a cusp magnetic field. Magnetic probe measurements show that during injection a diamagnetic region forms over a radius which varies inversely with the axial field strength for each type plasma. Axial velocities of the dense plasma are measured with a movable loop-permanent magnet as-

sembly. For deuterium the mean axial velocity is $v_0 = 8.7 \pm 0.5 \times 10^6$ cm/sec, for helium $v_0 = 1.08 \pm 0.5 \times 10^7$ cm/sec and for hydrogen $1.4 \pm 0.1 \times 10^7$ cm/sec. Optical emission line shapes for helium show a Doppler width equal to 118 ± 11 ev in the peak axial field region during injection. Deuterium emission lines give both ion kinetic temperature and ion densities after injection which indicate reasonable containment with high β (β = internal plasma pressure/external field pressure). A simple hydrodynamic model of a supersonic diffuser compares favorably with the experimental observations during injection for both deuterium and helium. (auth)

18911 SYNCHROTRON RADIATION FROM MIRROR MACHINE GEOMETRIES. David B. Beard and John C. Baker (Univ. of California, Davis). *Phys. Fluids*, 4: 611-18(May 1961).

The radiation due to the orbiting of electrons in a confining magnetic field is numerically integrated over a thermal velocity distribution perpendicular to the magnetic field as a function of frequency of emitted radiation and the angle the radiation propagation vector makes with the magnetic field. The general dependence of the emission on angle and frequency is examined by the use of various approximations and is shown to agree with the numerical calculations. The result for a velocity distribution perpendicular to the magnetic field does not correspond with an isotropic velocity distribution. (auth)

18912 MAGNETIC FIELD DIFFUSION IN ZETA. D. J. Lees and M. G. Rusbridge (Atomic Energy Research Establishment, Harwell, Berks, Eng.). *Phys. Fluids*, 4: 653-4(May 1961).

The diffusion time τ of a plasma, i.e., the time necessary for the initial surface currents to diffuse into the plasma body, is considered. A theoretical value for τ is found, assuming that the plasma acts as a cylindrical conductor of isotropic conductivity. It is shown that τ should be proportional to $(\text{electron temperature})^{3/2} = T^{3/2}$. Measurements in ZETA are used to show that these values of τ are of the wrong order of magnitude, and that the theoretical and experimental dependences of τ on T are in disagreement. Mechanisms are proposed to explain this discrepancy. (T.F.H.)

18913 CYCLOTRON EMISSION FROM PLASMAS WITH NON-MAXWELLIAN DISTRIBUTIONS. G. Bekefi, Jay L. Hirshfield, and Sanborn C. Brown (Massachusetts Inst. of Tech., Cambridge). *Phys. Rev.*, 122: 1037-42(May 15, 1961).

Cyclotron emission from high-energy plasmas is calculated for two classes of electron distribution functions: those that decrease monotonically with increasing electron energy, and those that have one or more maxima displaced from zero energy. In the first case, the emission does not differ greatly from the emission of a Maxwellian plasma with the same energy. In the second case the emission can grow exponentially with distance traversed in the plasma, resulting in a greatly enhanced loss of radiant power. (auth)

18914 THE FRICTION AND DIFFUSION COEFFICIENTS OF THE FOKKER-PLANCK EQUATION IN A PLASMA. [Part] II. J. Hubbard (Atomic Energy Research Establishment, Harwell, Eng.). *Proc. Roy. Soc. (London)*, A, 261: 371-87(May 16, 1961).

A method of calculation of the coefficients of the Fokker-Planck equation is discussed, which includes in a proper way correlation effects between distant particles. The theory is extended to include a proper treatment of close binary encounters. It is also shown that the higher-order terms of the Fokker-Planck equation may be summed to

produce a Boltzmann-like contribution to the collision term. It is shown that in the approximation in which only 'dominant' terms are retained, the theory reproduces a number of well-known formulas, including the ordinary Boltzmann collision term, but with a suitable cut-off built in. (auth)

18915 ON ESCAPE OF A PLASMA FROM A MAGNETIC MIRROR TRAP. II. M. S. Ioffe, R. I. Sobolev, V. G. Tel'kovskii, and E. E. Yushmanov. *Zhur. Eksptl'. i Teoret. Fiz.*, 40: 40-8(Jan. 1961). (In Russian)

The anomalously rapid escape of a plasma from a magnetic mirror trap previously discovered is investigated. By measuring the ion component of the current striking the trap wall it is shown that the escape is due to movement of the plasma across the magnetic field and disappearance of most of the charged particles at the lateral wall. (auth)

18916 INTERACTION OF FAST ELECTRON BEAMS WITH LONGITUDINAL PLASMA WAVES. Yu. A. Romanov and G. F. Filippov. *Zhur. Eksptl'. i Teoret. Fiz.*, 40: 123-32(Jan. 1961). (In Russian)

Equations are derived which yield the time variation of the plasma wave spectral density and fast electron distribution function for arbitrary electron velocity distributions. The dispersion relation for the stationary problem is solved and the duration of the exponential stage of slowing down the monochromatic beam is estimated. (auth)

18917 ON THE DISTURBANCES PRODUCED BY A BODY MOVING IN A PLASMA. L. P. Pitaevskii and V. Z. Kresin (Inst. of Earth Magnetism, Ionosphere, and Radio-Wave Propagation, Academy of Sciences, USSR). *Zhur. Eksptl'. i Teoret. Fiz.*, 40: 271-81(Jan. 1961). (In Russian)

An expression is derived for the Fourier components n_q of the electron density disturbance produced by a moving body in a plasma in the limit when the wave vector $q \rightarrow 0$. It is shown, in particular, that the exact expression for n_q contains terms $\sim 1/q$ which are absent in the first approximation of perturbation theory. The formulas are employed to calculate in various particular cases the effective cross section for scattering of electromagnetic waves possessing wave lengths considerably exceeding the characteristic dimension of the body. (auth)

18918 ON THE TURBULENCE OF A PLASMA IN A MAGNETIC MIRROR TRAP. B. B. Kadomtsev. *Zhur. Eksptl'. i Teoret. Fiz.*, 40: 328-36(Jan. 1961). (In Russian)

Convective turbulence of a rarefied plasma in a magnetic mirror trap is considered theoretically. The turbulence arises as a result of instability of the plasma in such a trap. The results satisfactorily agree with the experimental results of Ioffe, Tel'kovskii, Sobolev and Yushmanov regarding the lifetime of the plasma in a trap of the considered type. (auth)

18919 CHANNEL EXPANSION OF TINY SPARKS. B. A. Demidov, Yu. F. Skachkov, and S. D. Fanchenko. *Zhur. Eksptl'. i Teoret. Fiz.*, 40: 384-90(Feb. 1961). (In Russian)

The expansion of the channel of sparks produced in oxygen and nitrogen (pressure up to 10 atm), deuterium (pressure up to 13 atm) and hydrogen (pressure up to 20 atm) by discharging of low inductance 30- and 6300-pF capacitors was studied by the electron optical chronography method. The maximal current build-up rate was of the order of $3 \cdot 10^{12}$ amp/sec. The calculated peak current was 10^3 amp and the calculated current density in the spark channel reached 10^8 - 10^9 amp/cm². The initial expansion of the channel is due to the propagation of a cylindrical shock wave with a velocity up to $6 \cdot 10^6$ cm/sec in nitrogen, up to $8 \cdot 10^6$ cm/sec in hydrogen and up to $7 \cdot 10^6$ cm/sec in deuterium (in the

latter case the temperature of the shock wave front is $\sim 8\text{ev}$. In hydrogen the calculated spark channel temperature $T_{\text{ch}} \sim 22\text{ev}$. (auth)

18920 CONFINEMENT OF A PLASMA BY A MAGNETIC FIELD WHICH INCREASES TOWARDS THE PERIPHERY. S. Yu. Luk'yanov, I. M. Podgornyi, and V. N. Sumarov. Zhur. Eksptl'. i Teoret. Fiz., 40: 448-51 (Feb. 1961). (In Russian)

The behavior of a plasma with a density of 10^{13} to 10^{14} cm^{-3} trapped by a magnetic field which increases toward the periphery is investigated. It is shown by ultra-high speed photography that plasma instabilities which decrease the confinement time may arise in such traps. (auth)

18921 ATTENUATION OF WAVES IN MAGNETIC HYDRODYNAMICS WITH ANISOTROPIC CONDUCTIVITY AND VISCOSITY. R. V. Doich (Moscow State Univ.). Zhur. Eksptl'. i Teoret. Fiz., 40: 524-6 (Feb. 1961). (In Russian)

Attenuation of weak magnetohydrodynamic and magnetoacoustic waves in an anisotropic plasma located in an external magnetic field is considered for the case when the wave frequency is smaller than the particle collision frequency and the wave length is larger than the mean free path. (auth)

18922 INSTABILITY OF LOW FREQUENCY ELECTROMAGNETIC WAVES IN A PLASMA TRAVERSED BY A BEAM OF CHARGED PARTICLES. M. S. Kovner (Gorki State Univ., USSR). Zhur. Eksptl'. i Teoret. Fiz., 40: 527-36 (Feb. 1961). (In Russian)

The stability of low frequency longitudinal and transverse waves in a magnetoactive plasma traversed by a beam of charged particles is considered. The plasma and beam are assumed homogeneous and infinite. The perturbations in the form of plane waves move along a constant external magnetic field. Conditions determining the stability of the system are derived and in some cases the coefficients of wave growth are found. (auth)

18923 ELECTROMAGNETIC PROPERTIES OF A RELATIVISTIC PLASMA. [PART] II. V. P. Silin. Zhur. Eksptl'. i Teoret. Fiz., 40: 616-25 (Feb. 1961). (In Russian)

The reflection and absorption of electromagnetic radiation incident at a right angle to the plane confining an electron plasma with a relativistic momentum distribution of particles are considered. The surface impedance of the plasma is computed for relativistic as well as nonrelativistic temperatures. Specular and diffuse reflection of the electrons from the plasma surface is considered. (auth)

18924 SPECTROSCOPIC INVESTIGATION OF HEAT PLASMA. A. N. Zaidel, G. M. Malyshev (Malishev), and E. Ya. (Ja.) Shreider (Ioffe Inst. of Physics and Technology, Leningrad). Zhur. Tekh. Fiz., 31: 129-66 (Feb. 1961). (In Russian)

Spectroscopic studies of hot plasma in the region from tens to 7000 Å are reviewed. Optical methods, plasma luminescence, electron temperature, particle concentrations, and various space-time glow characteristics are discussed, 119 references. (R.V.J.)

18925 ABOUT THE GENERATION OF ELECTROMAGNETIC WAVES IN MAGNETOACTIVE PLASMA WITH THE BEAM OF CHARGED PARTICLES. K. N. Stepanov and A. B. Kitsenko (Inst. of Physics and Tech., Khar'kov). Zhur. Tekh. Fiz., 31: 167-75 (Feb. 1961). (In Russian)

Cherenkov and cyclotron excitation of "slow" electromagnetic waves in plasma, produced by a charged particle

beam passing through the plasma parallel to the external magnetic field, is investigated. (tr-auth)

18926 ABOUT CYCLOTRON NON-STABILITY OF PLASMA. A. B. Kitsenko and K. N. Stepanov (Inst. of Physics and Tech., Khar'kov). Zhur. Tekh. Fiz., 31: 176-9 (Feb. 1961). (In Russian)

It is shown that instability for perturbations of Larmor radius order and frequencies equal to or exceeding ion gyro-frequencies may appear in plasma with anisotropic ion distribution. The increment of the first harmonics increases with equal orders of magnitude. (tr-auth)

18927 THE STABILITY OF THE PLASMA-VACUUM BOUNDARY. E. P. Velikhov. Zhur. Tekh. Fiz., 31: 180-7 (Feb. 1961). (In Russian)

A simple two-dimensional model of a homogeneous plasma layer with ρ density and internal magnetic field, supported against ρg forces by an external field, is used for studying stability. It is shown that stability adjacent to conducting walls separated by a distance $2L_2$ is: $\pi B_0^2 / 16 L_1 L_2 P_0 > g/l$ where g is the acceleration inducing charge separation; $2L_1$ is the plasma width. With instability related to centrifugal force the $g \sim v_{\parallel}^2 / R_0^2$, when v_{\parallel} is the velocity of the particle along the lines of force and R_0 is the radius of curvature. Then $\pi B_0^2 / 16 L_1 L_2 P_0 > v_{\parallel}^2 / (R_0^2 \sim TR / MR_0)$ and the stability is $\beta = 8\pi p / B_0^2 < (\pi^2 / 2) (l R_0 / L_1 L_2)$ (this is correct assuming $\beta \approx 1$). (R.V.J.)

18928 THE DISTRIBUTION OF ION CYCLOTRON WAVES IN PLASMA. N. I. Nasarov, A. I. Ermakov, V. T. Tolok, and K. D. Sinelnikov (Inst. of Physics and Tech., Academy of Sciences, Khar'kov). Zhur. Tekh. Fiz., 31: 254-5 (Feb. 1961). (In Russian)

A gas discharge was formed in a 1.6-m long, 60-mm diameter glass tube placed in an axial magnetic field of 15 kgauss. The magnetic field reached a maximum value in 10^{-2} sec and dropped 2.7-fold in 8×10^{-2} sec. Hydrogen at 10^{-4} to 10^{-2} mm mercury was used. The maximum hydrogen H_2 ionization took place in 0.5 msec. The propagation of ion cyclotron waves along the magnetic field was observed; the plotted intensity and high-frequency signals show that the wave signal amplitude is a function of ionization. The results confirm previous postulations on high-frequency energy penetration of plasma in the form of cyclotron waves. (R.V.J.)

18929 THE INVESTIGATION OF THE DISCHARGE WITHOUT ELECTRODES IN THE MAGNETIC TRAP WITH AZIMUTHAL MAGNETIC FIELD. Ya. (Ja) F. Volkov, V. T. Tolok, and K. D. Sinelnikov. Zhur. Tekh. Fiz., 31: 255-8 (Feb. 1961). (In Russian)

The initial azimuthal magnetic field capable of preventing strong contraction of a plasma cylinder without changing the pinch was used in an experiment designed to explain the interactions of plasma and magnetic fields. Studies were also made of the γ radiation which ordinarily follows the interaction. Pictures of a 0.3 μsec discharge in argon show that the H_ϕ field created prevents plasma constriction; the plasma appears not as a hollow cylinder but as two coaxial cylinders. Z-axis drift is induced by a force resulting from their motion toward the H_ϕ axis. Changing the sign of H_ϕ reversed the drift. Identical observations were made on discharges in hydrogen. (R.V.J.)

18930 THERMONUCLEAR REACTOR. (to U. S. Atomic Energy Commission). British Patent 866,544. Apr. 26, 1961.

The stellarator relates generally to reactors and more particularly to methods of and apparatus for producing and controlling thermonuclear reactions, absorbing the energy

released thereby, and capturing nuclear particles radiated in such reactions. The stellarator is comprised of a continuous tube having reactants therein and having at least one diverter section. It has means for ohmically heating the reactants to an intermediate temperature, for heating and ionizing the reactants to thermonuclear temperatures, for confining the reactants to a central axial portion, and for removing the reactant and reacted particles approaching the walls of the tube. (N.W.R.)

18931 METHOD AND APPARATUS FOR HEATING A PLASMA. (to U. S. Atomic Energy Commission). British Patent 867,315. May 3, 1961.

A method for transferring energy to a plasma in a confining magnetic field and particularly for heating a plasma of low atomic number ions to thermonuclear reaction temperature is described. The method consists of establishing an electric field within the plasma in an evacuated zone. The electric field has a time and spatial periodicity causing a natural resonance in the plasma. The energy in the plasma is thermalized by cyclotron damping. The confining magnetic field is quasi-static. It consists of a resonating magnetic field in the plasma having a spatial periodicity along the lines of force and a varying flux density, whereby the resonating electric field is induced. (N.W.R.)

Shielding

18932 (TID-12743) NUCLEAR PREANALYSES OF THE PROPOSED SHIELD TEST AT GEORGIA NUCLEAR LABORATORIES. J. A. Belcher and L. K. Zoller (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Mar. 9, 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 39p. (XDC-61-4-49)

Nuclear preanalyses data for a proposed shield test are presented. The preanalyses were run for two reactor-test specimen configurations since the specimen placement evaluation was incomplete. The Radiation Effects Reactor is a light-water moderated and cooled swimming pool type core with MTR type fuel elements. The two configurations studied were as follows: approximately 3 in. outside of the shield tank or about 10 in. from the containment vessel. The fast neutron dose rates, gamma dose rates, and gamma heating rates were calculated with Shielding Program 14-0. The neutron heating rates and foil responses were calculated with 19 group diffusion code, G-2. (M.C.G.)

18933 (VDIT-32(1)) NUCLEAR REACTOR SHIELDING. PART I. A Literature Survey. Ernst Bock and Margareta Jarnholt (Aktiebolaget Atomenergi, Stockholm). Mar. 1961. 45p.

Prepared for the EAES-Symposium on Nuclear Reactor Shielding, held at Studsvik, March 27-29, 1961.

A literature survey including 171 abstracts is presented on both theoretical and experimental aspects of reactor shielding and covers research results published in two years up to March 1961. An author index is included. (D.L.C.)

18934 GAMMA DOSE IN A HOLE IN A UNIFORMLY CONTAMINATED PLANE: CONTRIBUTION BY GROUND PENETRATION. C. E. Clifford (Defence Research Chemical Labs., Ottawa). Can. J. Phys., 39: 604-8 (Apr. 1961). (DRCL-310A)

A cylindrical hole in a uniformly γ -contaminated plane (e.g., a foxhole in a level field) is considered. The γ dose from ground penetration is measured as a function of depth in the hole, using a Cs^{137} source. Skyshine effects are not measured. (T.F.H.)

Theoretical Physics

18935 (CERN-61-6) INTRODUCTION TO FIELD THEORY AND DISPERSION RELATIONS. R. Hagedorn (European Organization for Nuclear Research, Geneva). Feb. 14, 1961. 174p.

The introduction is presented to acquaint those who already know something about field theory with the more recent developments which lead to dispersion relations. The information is presented in sections on the Hamiltonian Formalism, new formulation of Field Theory, consequences of the principles in terms of field operators' properties, the reduction technique, and dispersion relations. (J.R.D.)

18936 (JINR-D-676) GAUGE INVARIANT FORMULATION OF THE NEUTRAL VECTOR FIELD THEORY. V. I. Ogievetskii (Ogievetski) and I. V. Polubarinov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1961. 16p.

It is shown that the theory of the neutral vector field with nonzero rest mass may be formulated in a gauge-invariant form without introducing auxiliary fields. The gauge invariance in such a theory has a trivial physical meaning: the zero spin quanta described by a four-vector A_μ interact with nothing. Only the quanta with spin 1 interact. (auth)

18937 (OOR-1271.31) APPLICATION OF INVARIANCE PRINCIPLES IN CONTINUUM MECHANICS. Technical Report No. 8, September 1959-January 1961. Cover carries title: FLOWS OF DILATANT FLUIDS. Eric Varley (Brown Univ., Providence). Mar. 1, 1961. Contract DA-19-020-ORD-4725. 74p.

Constitutive equations for both compressible and incompressible dilatant fluids were constructed for general stress fields. General features of the rectilinear flow of an incompressible dilatant fluid down pipes of arbitrary cross-section and the details for a particular cross-section are given. A maximum principle for the admissible motions of the boundaries and a uniqueness theorem for steady creeping motion were established. The equations governing the two-dimensional dilatant flow of a von Mises dilatant fluid adjacent to a rigid body were integrated and certain anomalies which arise when the Reynolds number is infinite are discussed. Three examples of unsteady shear flow are also given. For the compressible dilatant fluid the shock-like structure of the dilatant layer was determined and it is shown that the classical 'inviscid' shock is a limiting case of a dilatant fluid. (auth)

18938 (OOR-1911.3) EVOLUTION OF A QUASI-STATIONARY STATE. Interim Technical Report No. 2. Rolf G. Winter (Pennsylvania State Univ., University Park). Mar. 30, 1961. Contract DA-36-061-ORD 592. 21p.

To elucidate the time development of quasi-stationary states, a simple barrier penetration problem was studied. Both approximate expressions and numerical results for some parameters were obtained for the decay rate. Irregular oscillations occurred for a short time followed by the exponential region. Then further oscillations occurred during which the decay rate dipped to negative values, so that the probability of finding the undecayed system increased briefly at several times. Finally, the decay rate decreased like an inverse power of time. (auth)

18939 (JPRS-7963) COSMIC RADIATION FROM THE SUN. L. V. Kurnosova, et al. Translated from Priroda, No. 1, 94-6 (Jan. 1961). 6p.

A discussion is given of the observations of the increase in cosmic radiation intensity occurring on Sept. 12, 1959.

The observations which were made by the second cosmic rocket were confirmed by the Cracow Observatory and the Observatory of the Institute of Terrestrial Magnetism. Short bursts of intense solar radio emission were detected at 11.29 hr at 810 Mc at Cracow and 11.37 hr at 208 Mc at the Institute of Terrestrial Magnetism. The increases in intensity, recorded by the rocket, are characterized by the fact that the nuclear components were most marked in the case of heavy nuclei. (JPRS)

18940 ON THE CONNECTION OF SPIN AND COMMUTATION RELATIONS BETWEEN DIFFERENT FIELDS. Huzihiro Araki (Kyoto Univ.). *J. Math. Phys.*, 2: 267-70 (May-June 1961).

The connection of spin and commutation relations for different fields is studied. The normal locality is defined as the property that two boson fields or boson field and a fermion field commute, while two fermion fields anticommute with each other at a spacelike distance. A regular locality is defined as any combination of commutativity and anticommutativity between various pairs of fields at spacelike distance, where the kinematically related fields are assumed to obey the same type of commutation relations. The normal and regular weak locality is defined in a corresponding way. It is proved on the basis of the Lorentz invariance and spectrum conditions that any regular locality is equivalent to the normal locality plus a set of even-oddness conservation laws. It is further shown, under the assumption of the normal weak locality between pairs of the same field, that any regular weak locality is equivalent to the normal weak locality plus a set of even-oddness conservation laws. (auth)

18941 FREE QUANTIZED LORENTZIAN FIELDS. J. Schwartz (New York Univ.). *J. Math. Phys.*, 2: 271-90 (May-June 1961).

A systematic classification is made of all local Lorentz-invariant quantized field theories that are free in the sense that $\{\psi(x), \psi(x')\}$ is a c number. It is shown that no fields of this type exist other than those given by Fierz, and that, in fact, certain of the fields listed by Fierz are redundant. (auth)

18942 FREE PROPAGATOR EXPANSION IN THE EVALUATION OF THE LAMB SHIFT. PART I. Arthur J. Layzer (Columbia Univ., N. Y.). *J. Math. Phys.*, 2: 292-307 (May-June 1961).

A study is made of the "order properties," with respect to the parameter αZ , of an expansion method for the evaluation of the bound electron self-energy ΔE , and the application of these properties to the calculation of the new Lamb shift orders of $\alpha(\alpha Z)^6 \ln^2(\alpha Z)$ and $\alpha(\alpha Z)^6 \ln(\alpha Z)$. The expansion method is the free-propagator expansion (FPE); that is, the formal algebraic expansion of the bound electron propagator or Green's function in "powers" of the external (Coulomb) potential. The principal result of the general mathematical analysis is a theorem which asserts that the FPE is an order expansion for (only) those terms of ΔE that are nonanalytic in the parameter $w \equiv (\alpha Z)^2$ and that the FPE is thus suitable for the calculation of this class of terms. A result of the theorem is that the new logarithmic orders arise from only the first four terms of the FPE. The nonanalytic part of a fixed term I_n of the FPE can be attacked directly through a consideration of $\text{Im}_+ I_n$, where $\text{Im}_+ I_n$ denotes the imaginary part of I_n , regarded as a function of the complex variable w , on the upper side of a branch cut along the negative w axis. As an auxiliary result, boundedness properties in momentum space are derived for certain iterated operators related to the FPE of the bound nonrelativistic electron Green's function. (auth)

18943 FREE PROPAGATOR EXPANSION IN THE EVALUATION OF THE LAMB SHIFT. PART II. Arthur J. Layzer (Columbia Univ., N. Y.). *J. Math. Phys.*, 2: 308-23 (May-June 1961).

A free-propagator expansion method is applied to the calculation of the new Lamb shift orders of $\alpha w^3 \ln^2 w$ and $\alpha w^3 \ln w$ [$w \equiv (\alpha Z)^2$]. The result for the $2S-2P_{1/2}$ shift due to the \ln^2 and \ln terms is $\Delta E(2S-2P_{1/2}) = -Lw^{3/4} \ln^2 w + \ln w(4 \ln 2 + 1 + 7/48)$ where L is Z^4 times the Lamb unit. In megacycles this is -0.25 for H and -9.5 for He^+ . The corresponding new values for the total theoretical shift are 1057.70 ± 0.15 , 1059.08 ± 0.16 , and 14047.2 ± 3.0 for H, D, and He^+ , respectively. These values incorporate estimates for the nuclear finite size effect in D and He^+ . (auth)

18944 OPERATOR FORMALISM IN STATISTICAL MECHANICS. Elliott Lieb (IBM Research Lab., Yorktown Heights, N. Y.). *J. Math. Phys.*, 2: 341-3 (May-June 1961).

The configuration partition function, Z_N , of a classical imperfect gas of N particles having rigid cores is considered. The rigid cores result in a geometric simplification that makes possible the finding of a finite recursion relation between Z_N and Z_{N-1} . From this relation, it is possible to express Z_N in terms of the vacuum expectation value of a finite boson operator raised to the N th power. (auth)

18945 EQUIPARTITION OF ENERGY FOR NONLINEAR SYSTEMS. Joseph Ford (Univ. of Miami, Coral Gables, Fla.). *J. Math. Phys.*, 2: 387-93 (May-June 1961).

A system of harmonic oscillators weakly coupled by nonlinear forces does not achieve equipartition of energy as long as the uncoupled frequencies ω_k are linearly independent on the integers, i.e., as long as there is no collection of integers $\{n_k\}$ for which $\sum n_k \omega_k = 0$ other than all $n_k = 0$. This result is shown to follow from the general form of the Kryloff and Bogoliuboff series solution to the equations of motion. Physically, the linear independence of the uncoupled frequencies means that none of the interacting oscillators drives another at its resonant frequency; this lack of internal resonance precludes appreciable energy sharing in the limit as the coupling tends to zero. It is shown that the lack of equipartition of energy for certain nonlinear systems may be explained in terms of this analysis. A particular system of linear differential equations is solved which illustrates a mechanism whereby oscillator systems may achieve equipartition of energy. (auth)

18946 HIGHER-ORDER APPROXIMATIONS IN MULTIPLE SCATTERING. I. TWO-DIMENSIONAL SCALAR CASE. Norman Zitron and Samuel N. Karp (New York Univ.). *J. Math. Phys.*, 2: 394-402 (May-June 1961).

A formula is derived that expresses the perturbed scattering amplitudes of a combination of two arbitrary cylinders as a function of the unperturbed scattering amplitudes of the individual cylinders. The formula is valid when the spacing of the scatterers is large compared to their dimensions. The formula involves derivatives of the scattering amplitudes with respect to the angles of incidence and of observation. Interaction terms of degrees $d^{-1/2}$, d^{-1} , and $d^{-3/2}$ are taken into account, where d is the spacing. Verification is obtained in a special case. The result is employed to calculate the total scattering cross section. (auth)

18947 HIGHER-ORDER APPROXIMATIONS IN MULTIPLE SCATTERING. II. THREE-DIMENSIONAL SCALAR CASE. Norman Zitron (Harvard Univ., Cambridge, Mass.) and Samuel N. Karp. *J. Math. Phys.*, 2: 402-6 (May-June, 1961).

A formula is derived for the perturbed diffracting amplitudes of a combination of 2 bodies of arbitrary shape as a

function of the unperturbed diffracting amplitude of the individual bodies. The formula is valid for large separation-body size ratios. Interaction terms of order d^{-1} and d^{-2} are given, where d is the separation. (T.F.H.)

18948 WIGNER COEFFICIENTS FOR THE R_4 GROUP AND SOME APPLICATIONS. L. C. Biedenharn (Duke Univ., Durham, N. C.). *J. Math. Phys.*, 2: 433-41 (May-June 1961).

The local isomorphism of the R_4 group to the $R_3 \times R_3$ group is utilized to obtain R_4 Wigner coefficients for those representations in which the subgroup R_3 is diagonal. The R_4 Wigner coefficients so defined are then used to obtain recursion relations and differential equations for the representation coefficients, when the R_4 group is parametrized appropriately. The R_4 spherical harmonics, and their properties, are explicitly obtained as specializations of the general formulas. A physical application to the problem of geometrizing the Coulomb field is discussed. (auth)

18949 ELLIPSOIDAL DISTRIBUTIONS OF CHARGE OR MASS. B. C. Carlson (Ames Lab., Ames, Iowa). *J. Math. Phys.*, 2: 441-50 (May-June 1961). (ISC-201)

The Coulomb (or gravitational) energy is calculated for a distribution of charge (or mass) in which the surfaces of constant density are a family of similar concentric ellipsoids. The density can vary in any manner from one surface to another, and the ellipsoids need not have an axis of symmetry. Two examples are discussed, the charge distribution of a deformed atomic nucleus having a diffuse surface, and the mass distribution of a stellar galaxy. The energy is shown to be a product of two factors. One factor is the energy of the spherical distribution from which the ellipsoidal distribution can be obtained by a volume-preserving deformation. The other factor is an anisotropy property that has a simple geometrical significance and depends only on the two eccentricities of the ellipsoids. Its values range from unity to zero. (auth)

18950 A REMARK ON THE ISOBARIC SPIN SPACE. Th. A. J. Maris (Universidade do Rio Grande do Sul, Porto Alegre, Brazil). *Nuclear Phys.*, 24: 346-52 (1961). (In English)

Usually a physical meaning is given to only half of the solutions of the Klein-Gordon equation for a 4-component spinor. It is shown that the isobaric spin degrees of freedom of a free fermion-isofermion field can be simply interpreted by considering all the solutions of the Klein-Gordon equation to be meaningful. Explicit expressions for the isobaric spin operators in spinor and configuration space quantities are given. The conserved current of one of the isobaric spin components is the axial vector current. (auth)

18951 ON THE THEORY OF PRIMARY SPECIFIC IONIZATION IN HELIUM. R. T. Van de Walle and C. C. Grosjean (Rijksuniversiteit, Ghent). *Nuovo cimento* (10), 19: 872-902 (Mar. 1, 1961). (In English)

An improved formula is derived for the non-relativistic primary specific ionization $S(\beta)$ of electrons in helium, as a result of a theory in which numerically computed helium wave functions are introduced instead of less accurate hydrogenic wave functions. The differential cross section for inelastic scattering of an incident electron by a helium atom is calculated, on the basis of a method for treating rearrangement collisions that makes use of the Born approximation. The resulting formula is applied to the problem under consideration; it is shown that the terms due to spin-exchange effects can be neglected under the prevailing conditions of validity. The various parts of the remaining simplified formula for the differential cross section are

then calculated explicitly. Summations and integrations that lead to $S(\beta)$ are carried out. One of these integrations is studied in detail, since it necessitates the introduction of additional simplifying approximations. The result for $S(\beta)$ is discussed and compared with a formula derived from the work of Bethe. A graphical representation permits a comparison with experiment. The main conclusion is that the new formula is able to account for as much as 25% of the discrepancy between Bethe's formula and experiment. The velocity distributions of the secondary electrons ejected from the helium atoms during the process of primary ionization in various angular momentum quantum states, characterized by the non-negative integer l , are studied. The general behavior of the cross sections per unit β -interval (β being a convenient dimensionless velocity parameter) corresponding to $l = 0, 1$, and 2 is interpreted. These cross sections are also compared with their respective analytic counterparts in which Coulomb wave functions are used to describe approximately the final states of the ejected electrons. (auth)

18952 A PROOF OF THE MANDELSTAM REPRESENTATION IN PERTURBATION THEORY. P. V. Landshoff (St. John's Coll., Cambridge, Eng.), J. C. Polkinghorne, and J. C. Taylor. *Nuovo cimento* (10), 19: 939-52 (Mar. 1, 1961). (In English)

The Mandelstam representation is proved in each finite order in perturbation theory, for processes for which forward scattering dispersion relations are known. A continuation in the external masses is then made, so that the proof is extended to all processes for which there is no anomalous threshold in lowest order. (auth)

18953 ON RADIATIVE CORRECTIONS DUE TO SOFT PHOTONS. K. E. Eriksson (CERN, Geneva). *Nuovo cimento* (10), 19: 1010-28 (Mar. 1, 1961). (In English)

A method is shown by which the infra-red divergent part, due to soft virtual photons, of any scattering amplitude can be factorized in a Lorentz invariant manner. It is further shown that if the energy resolution for a process is negligible compared to the electron rest mass then the whole soft photon contribution to the transition probability density can be factorized leaving a Lorentz-invariant remainder. This factorization is then extended to the more realistic case of an energy resolution which is of the same order of magnitude as the electron rest mass, or larger. Finally, the magnitudes of radiative corrections are discussed. (auth)

18954 RADIATIVE CORRECTIONS TO MUON-ELECTRON SCATTERING. K. E. Eriksson (CERN, Geneva). *Nuovo cimento* (10), 19: 1029-43 (Mar. 1, 1961). (In English)

The differential cross-section for μ -e scattering is calculated to order e^4 . (auth)

18955 HIGH-ENERGY BEHAVIOR OF ELECTROMAGNETIC SCATTERING CROSS-SECTIONS. K. E. Eriksson (CERN, Geneva). *Nuovo cimento* (10), 19: 1044-52 (Mar. 1, 1961). (In English)

The theory of the renormalization group is used in order to find, for large momentum transfer, the perturbation expansion in α of the differential cross-section for the scattering of an electron by a potential. In first order Born approximation, this expansion is given in terms of the effective parameter $(\alpha/\pi) \ln(q^2/m^2)$, where q = invariant momentum transfer, m = electron rest mass; $q/m \gg 1$. (auth)

18956 EFFECTS OF CENTRE-OF-MASS MOTION IN THE NUCLEAR SHELL MODEL ON SCATTERING PROBLEMS. F. C. Barker (Australian National Univ., Canberra)

and L. J. Tassie. *Nuovo cimento* (10), 19: 1211-17(Mar. 16, 1961). (In English)

The nuclear shell model does not describe correctly the motion of the center of mass of the nucleus. The correction due to this is considered for scattering problems, and especially for the scattering of high-energy electrons. The interactions of the electrons with the nuclear current and magnetization densities as well as with the charge density are included. The correction is obtained only for the harmonic-oscillator shell model. (auth)

18957 TOWARDS A TWO-FIELD THEORY OF ELEMENTARY PARTICLES. R. E. Marshak and S. Okubo (CERN, Geneva). *Nuovo cimento* (10), 19: 1226-48(Mar. 16, 1961). (In English)

It is shown that the symmetry principle between the baryon triplet (Λ np) and lepton triplet (μ ev) suggests a two-field theory of elementary particles. One massless spinor field is used to describe the nucleons and light leptons and a second spinor field with finite bare mass the "strange" particles Λ and μ . The two-field model resembles the theories of Heisenberg and Nambu in several respects but there are also important differences, which are enumerated. (auth)

18958 ANALYTIC PROPERTIES OF PRODUCTION AMPLITUDES. P. V. Landshoff (St. John's Coll., Cambridge, Eng.) and S. B. Treiman. *Nuovo cimento* (10), 19: 1249-56(Mar. 16, 1961). (In English)

It is shown that a production amplitude, considered as a function of a single scalar invariant, inevitably has complex singularities when four other scalar invariants are fixed at physical values. For the process $N + \pi \rightarrow N + \pi + \pi$, with the nucleon-nucleon momentum transfer as the variable, the singularities can appear close to the pole to which extrapolations have been made when the other scalar invariants are fixed at typical experimental values. (auth)

18959 S-MATRIX, LEFT-HAND CUT DISCONTINUITY AND POTENTIAL. A. Martin (CERN, Geneva). *Nuovo cimento* (10), 19: 1257-65(Mar. 16, 1961). (In English)

A two body potential that is a continuous superposition of exponential potentials is assumed. It is shown in a straightforward way how the scattering amplitude itself may be obtained unambiguously from a knowledge of the left-hand cut discontinuity of the S-wave scattering amplitude. Further, a one to one correspondence is established between the unphysical cut discontinuity and the inverse Laplace transform of the potential. When the discontinuity is known in a certain range of values the inverse Laplace transform of the potential is exactly known in a corresponding range of values. An extension of the treatment when a repulsive hard core is present at short distance is given. The usefulness of the inverse Laplace transform of the potential as an intermediate tool in the calculation of the scattering amplitude is discussed. (auth)

18960 ON A SCHRÖDINGER EQUATION FOR A RADIATING ELECTRON. G. Valentini (Universita, Milan). *Nuovo cimento* (10), 19: 1280-3(Mar. 16, 1961). (In English)

An electron subjected to electrodynamic reaction forces is considered in the case in which the forces are not derivable from a potential function. The Hamiltonian and Lagrangian formalisms are applied to the system; from these, a time-independent Schrödinger wave equation is derived for special cases of the potential function. This wave equation gives information as to the behavior of a radiating electron that is coupled with an electromagnetic field. (T.F.H.)

18961 GENERALIZED HARTREE-FOCK METHOD. J. G. Valatin (Univ. of Birmingham, Eng. and Inst. for Advanced Study, Princeton, N. J.). *Phys. Rev.*, 122: 1012-20(May 15, 1961).

A variational principle is formulated to determine the single-particle states, their pairing, and the occupation number distribution for a trial state vector of the Bardeen, Cooper, Schrieffer type. The equations which are derived generalize those of the Hartree-Fock method obtained with a Slater determinant trial wave function. It is pointed out that in a suitable representation the vacuum state of a general quasi-particle transformation has such a trial form which exhibits directly the pairing of single-particle states. Another variational principle determines the excitation energies. Two coupling cases are distinguished: the commutative case in which the self-consistent densities and energies are related to quantities which all commute, and the more general noncommutative case. The latter is of importance in critical-field phenomena. The equations for the commutative case can be written in a matrix form which retains its validity in the more general noncommutative case. The simple matrix commutator equations appear as direct generalizations of the density matrix form of the Hartree-Fock equations. The equations for small oscillations have an equally simple form. Their connection with a diagonal representation of the quasi-particle energies is exhibited in a way which remains valid in the general coupling case. The "unphysical" solutions are excluded by the supplementary condition. The contact with the Green's function approach is established. The generalized matrix form of the Green's function equations shows the symmetry properties of the method. (auth)

18962 THEORY OF STRONGLY COUPLED MANY-FERMION SYSTEMS. I. CONVERGENCE OF LINKED-CLUSTER EXPANSIONS. Leon N. Cooper (Brown Univ., Providence). *Phys. Rev.*, 122: 1021-8(May 15, 1961).

A strongly coupled system—the limiting case of a highly degenerate many-fermion system for which the variation of the kinetic energy is neglected, and the interaction restricted to a region of momentum space neighboring the Fermi surface—is analyzed with no assumptions concerning the convergence of power series expansions or on partial summations of infinite series. The vacuum expectation value of the resolvent operator, $\langle 1/(H-z) \rangle_0$, is expressed as the Laplace transform of the exponential of a function linearly dependent on the volume of the system. It is shown that the linked-cluster expansion of the vacuum expectation value of the resolvent operator has a zero radius of convergence as a power series in the coupling constant. The most serious physical consequence of this zero radius is that a nontrivial interaction never results in a "normal" system. (auth)

18963 LINKED-PAIR EXPANSIONS IN QUANTUM STATISTICS. Franz Mohling (Columbia Univ., New York). *Phys. Rev.*, 122: 1043-61(May 15, 1961).

In the quantum statistical method of Lee and Yang, the cluster functions of quantum statistics are expressed in terms of the cluster functions of Boltzmann statistics, which in turn are computed in terms of certain two-body functions. A study of the Boltzmann cluster functions shows that a symmetric representation can be used for the two-body functions and that large classes of diagrams can be summed. This leads to the introduction of linked-pair graphs to describe the functions of quantum statistics. The two-body functions are expressed in terms of two-body wave functions, and are therefore well-defined for hard-core repulsions. The method is shown for weak potentials. (auth)

18964 VERY LOW-TEMPERATURE FERMION GAS. Franz Møhling (Columbia Univ., New York). *Phys. Rev.*, 122: 1062-90(May 15, 1961).

The momentum distribution in a low-temperature Fermion gas is investigated using methods of quantum statistics together with linked-pair expansions. It is shown that in order to determine the momentum distribution at very low temperatures two coupled integral equations must be considered, one in momentum variables and the other in temperature variables. It is also shown that the dominant low-temperature behavior of the momentum distribution can be extracted in terms of a certain function $\nu'(k)$. For a low-density Fermion gas with strong, short-range, two-body interactions, it is shown to third order in the scattering parameters of the interaction that at $T = 0$ the function $\nu'(k)$ is equal to the free particle momentum distribution. Also, the energy and other thermodynamic quantities are expressed in terms of $\nu'(k)$, so that the theory permits a generalization of perturbation theoretic results to nonzero temperatures. The ground-state energy, momentum distribution, and thermodynamic potential are calculated to third order in the scattering parameters. (auth)

18965 STUDY OF SUPERCONDUCTORS BY ELECTRON TUNNELING. Ivar Giaever and Karl Megerle (General Electric Research Lab., Schenectady, N. Y.). *Phys. Rev.*, 122: 1101-11(May 15, 1961).

If a small potential difference is applied between two metals separated by a thin insulating film, a current flows because of the quantum mechanical tunnel effect. For both metals in the normal state the current-voltage characteristic is linear; for one of the metals in the superconducting state the current-voltage characteristic becomes nonlinear; and for both metals in the superconductive state a negative-resistance region is obtained. From these changes in the current-voltage characteristics, the change in the electron density of states when a metal goes from its normal to its superconductive state can be inferred. By using this technique the energy gap in metal films 1000 to 3000 Å thick at 1°K is found to be $2\epsilon_{pb} = (2.68 \pm 0.06) \times 10^{-3}$ ev, $2\epsilon_{sn} = (1.11 \pm 0.03) \times 10^{-3}$ ev, $2\epsilon_{ln} = (1.05 \pm 0.03) \times 10^{-3}$ ev, and $2\epsilon_{Al} = (0.32 \pm 0.03) \times 10^{-3}$ ev. The variation of the gap width with temperature is found. The energy gap in the films is found to depend upon the applied magnetic field, decreasing with increasing field. (auth)

18966 KINEMATICAL AND DYNAMICAL RESONANCES. A. O. Barut and K. H. Ruei (Syracuse Univ., N. Y.). *Phys. Rev.*, 122: 1340-2(May 15, 1961).

A method is given to distinguish between the solutions of the dispersion relations corresponding to kinematical and dynamical resonances. The method consists of studying the resonance energy as a function of the coupling constant. The method is illustrated for potential scattering, for charged scalar meson theory, and for resonances due to unstable particles. (auth)

18967 THE RIEMANN SURFACE OF THE SCATTERING AMPLITUDE. Chan Hong-Mo (Univ. of Birmingham, Eng.). *Proc. Roy. Soc. (London)*, A, 261: 329-56 (May 16, 1961).

The Fredholm technique is used to study analytic properties of the scattering amplitude as a function of both the energy and the momentum transfer, for Schrödinger and Klein-Gordon scattering from cut-off potentials and potentials with exponential and Yukawa tails. The discussion is extended to the case with several discrete channels. Relativistic scattering of elementary particles is discussed. Conjectures concerning the Riemann surface of the amplitude for the elastic scattering of two identical

particles are formulated, neglecting the production of further particles. With the use of the Mandelstam conjecture it is found that the Riemann 'surface' belonging to the scattering amplitude as an analytic function of the two independent Mandelstam variables has at least eight 'sheets'. The analogy between potential scattering and perturbation theory suggests the existence of further branch points on the 'unphysical' sheets, which would make the structure of the full Riemann 'surface' very complicated. Poles representing bound and metastable states on the Riemann surface are discussed. The reality and unitarity conditions are formulated and their implications studied. (auth)

18968 SYMMETRY RELATIONS FOR THE SUM OF TRANSFORMATION BRACKETS. M. Moshinsky and T. A. Brody (Universidad Nacional Autónoma de México). *Rev. mex. fis.*, 9: 181-212(1960). (In Spanish)

Symmetry relations are obtained for the transformation brackets for previously defined harmonic oscillator functions. These symmetry relations are obtained by interpreting the transformation brackets as matrices of representations of the unitary unimodular group in two dimensions. The dimension of these representations is obtained. Certain simple spin-orbit coupling and tensor potentials are discussed, and sum rules are obtained for the coefficients appearing in calculations with these types of forces. Recursion formulas and sum rules are derived. (auth)

18969 PROCESSES OF THE INTERACTION OF PHOTONS AND GRAVITONS IN QUANTUM FIELD THEORY. M. P. Korkina (Dnepropetrovsk State Univ., Ukr., SSR). *Ukrain. Fiz. Zhur.*, 5: 762-8(Nov.-Dec., 1960). (In Ukrainian)

The interaction of photons and gravitons is considered from the standpoint of the matrix formulation of the electromagnetic field equations. Schwinger's dynamic principle is employed to obtain from the Lagrangian the equations of the field and the law of conservation of the energy-pulse tensor. The gravitational field is taken in linear approximation of Birkhoff's theory. The effective cross sections are computed for processes of the second order—scattering, of photons by gravitons, scattering of photons by virtual gravitons, and generation of couples. Bremsstrahlung of photons in a gravitational field of heavy mass is considered among the third-order processes. (auth)

18970 INHOMOGENEOUS LORENTZ GROUP TRANSFORMATIONS AND RELATIVISTIC KINEMATICS OF POLARIZED STATES. V. I. Ritus (Lebedev Inst. of Physics, Academy of Sciences, USSR). *Zhur. Eksptl'. i Teoret. Fiz.*, 40: 352-64(Jan. 1961). (In Russian)

Representations of the inhomogeneous Lorentz group are considered which correspond to physical systems with a mass, momentum, and internal angular momentum whose polarization can be described by the projections of the internal angular momentum on a given direction or of the total angular momentum on the direction of the momentum (helicity). Representations are also considered which correspond to physical systems with zero mass whose polarization can be described only by the projection of the total angular momentum on the direction of the momentum. For these representations all inhomogeneous Lorentz group transformations defining the relativistic polarization kinematics are derived in an explicit form. The representations for zero mass systems are derived from those for systems with a mass $\kappa \neq 0$ by performing the limiting transition $\kappa \rightarrow 0$. (auth)

18971 ON THE PHYSICAL MEANING OF NEGATIVE PROBABILITIES. Zh. P. Vizh'e (J. P. Vigiér) and Ya. P. Terletskii (Henri Poincaré Inst., Paris). Zhur. Eksptl'. i Teoret. Fiz., 40: 508-12(Feb. 1961). (In Russian)

It is shown that in calculating the statistical averages of a series of physical quantities, the distribution function can be employed instead of the probability density. The distribution function is the mathematical expectation of the particle density and is proportional to the particle density for a single particle only if all particles are absolutely identical. For a set of particles and antiparticles (with respect to some one property) the distribution function may also assume negative values. In this case it is not proportional to the probability, but it can be used to compute the averages of a series of physical quantities. It is demonstrated that

in field theory of elementary particles the mean values of some quantities characterizing the entire field (energy, momentum, charges etc.) can be computed with the help of the corresponding distribution function. (auth)

18972 QUANTUM MECHANICS. Eugen Merzbacher. New York, John Wiley & Sons, Inc., 1961. 553p. \$12.00.

A treatment of nonrelativistic quantum mechanics is presented. Wave mechanics is developed, and uses of matrices in 1-dimensional wave problems and in spin formulations are described. Wave and matrix forms of quantum mechanics are unified in the Dirac formulation. Detailed study is given to scattering theory, angular momentum, and bound-state and time-dependent perturbation theory. (T.F.H.)

REACTOR TECHNOLOGY

General and Miscellaneous

18973 (AE-40) MEASUREMENTS OF THE FAST FISSION FACTOR (ϵ) IN UO_2 -ELEMENTS. O. Nyland (Aktiebolaget Atomenergi, Stockholm). Mar. 1961. 31p.

Experiments were undertaken to check the ϵ calculations for the R3/Adam reactor project and to obtain a more rigorous basis for calculations on fuel elements similar to the R3/Adam clusters. Various numbers of rods (19, 7, 1) and coolants (air, D_2O , H_2O) were investigated. The measurements were performed in the central channel of the R1 research reactor making it possible also to study the influence due to adjacent R1 fuel rods. The method used (an activation technique) gives directly the relationship R between the fission rates in U^{238} and U^{235} . Knowing this quantity it is possible to compute ϵ . However, since ϵ is dependent on how it is defined, it is more convenient to use R in a comparison with calculated values. (auth)

18974 (BAW-1178) INTERIM REPORT COVERING HOT EXPONENTIAL EXPERIMENTS USING GENERAL ELECTRIC MARITIME FUEL PINS. L. G. Barrett (Babcock and Wilcox Co. Critical Experiment Lab., Lynchburg, Va.). Nov. 1959. Contract AT(10-1)-2474. 20p.

A review is given of the performance evaluation of General Electric fuel pins in exponential experiments. The greatest problem is obtaining a valid relaxation length for the neutron flux along the axis. The relaxation length of the cores under study is long, and thus the contribution of the radial buckling predominates in the determination of the material buckling. (B.O.G.)

18975 (CEA-1827) PRINCIPE D'UN DISPOSITIF D'IRRADIATION A AZOTE LIQUIDE ET SA REALISATION POUR UTILISATION DANS UNE PILE PISCINE. (Principle of a Liquid Nitrogen Irradiation Device and its Realization for Use in a Swimming-Pool Type Reactor). L. Bochirol, J. Doulat, and L. Weil (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucléaires, Saclay). Jan. 19, 1961. 12p.

The problem of pile irradiation of samples immersed in liquid nitrogen was solved with total elimination of explosion hazards and with high reliability (no moving parts). The principle of the device is that of a double bath: one of high purity nitrogen cools the samples at the level of the core; a second of commercial nitrogen is located above the first one, outside the high radiation field, and works as a continuous condenser for the pure nitrogen, the flow-back of which is provided simply by gravity. The apparatus described was developed for a swimming-pool pile. It was designed to provide absolute protection against radiations and to allow the irradiated samples to be easily removed in the cold condition. This apparatus was operated for several months. In a fast flux greater than 10^{13} neutrons/cm².s and a γ flux of the order of 10^6 roentgens/h, the consumption of liquid nitrogen was of the order of 100 liters a day. (auth)

18976 (CEND-88) THE DEVELOPMENT AND TESTING OF THE UO_2 FUEL ELEMENT SYSTEM. Summary Report for Period May 14, 1959–May 31, 1960. (Combustion Engineering, Inc. Nuclear Div., Windsor, Conn.). June 1, 1960. Contract AT(30-1)-2379. 96p.

Results are presented which were obtained in experimental development of concepts which appear to offer the

greatest over-all fuel cycle cost reductions in water type reactors. Savings in advanced PWR fuel by use of thinner stainless steel clad is noted. In vibratory compaction studies it was found that densities of 91% of theoretical can be produced in four-foot-long rods. Experiments with MgO -filled tubes to determine the feasibility of using the Rock-Rite process to produce UO_2 fuel rods revealed that cladding is not affected when the reduction-in-area is limited to about 50%. Economic incentives were not established for replacing centrally enriched UO_2 pellets with surface-layer-enriched for increased burnup lifetimes. A welding process which is intended to eliminate some fuel element repair and inspection problems by fabrication of one layer of elements at a time appears feasible. In other developments the feasibility of ultrasonic inspection of tube-to-tube brazed joints in fuel clusters was established and results of experiments with dip brazing for fuel rod end closure indicate the feasibility of this process for production purposes. Recommendations are included for future work. (J.R.D.)

18977 (CF-61-4-28) EVALUATION OF IODINE VAPOR ADSORBERS FOR THE LOW INTENSITY TEST REACTOR (LITR) OFF-GAS SYSTEM. R. E. Adams and W. E. Browning, Jr. (Oak Ridge National Lab., Tenn.). Apr. 12, 1961. 12p.

A proposed addition of an iodine vapor adsorber to the off-gas system of the Low Intensity Test Reactor (LITR) was evaluated by comparing the atmospheric radiation doses to laboratory personnel that could result in the event of a partial reactor core meltdown in one case while utilizing the present off-gas system and in the other case with an iodine adsorber installed. It is shown by calculations that the thyroid dose would be reduced from 17.8 r to 56 mr if an iodine adsorber of 99.99% efficiency were included in the off-gas system. The addition of this adsorber would also reduce the total body dose from 84 mr to 55 mr. Based upon these calculated atmospheric radiation doses it was concluded that the addition of an activated charcoal iodine vapor adsorber will reduce the hazard to a more acceptable level. (auth)

18978 (CF-61-4-73) SOME TEMPERATURE ASPECTS OF THE HFIR CONTROL PLATE SYSTEM. L. A. Haack (Oak Ridge National Lab., Tenn.). Apr. 18, 1961. 35p.

The effects are examined of water flow rate through the control region on local bulk water temperature and on control plate surface temperature, radial thermal expansion, and thermal stress. Flow rates of 1200, 800, and 400 gpm are considered for each of three control plate positions typical of startup, mid-cycle, and end-of-cycle. Based on the factors investigated, the calculations indicate that a flow rate as low as 400 gpm may be reasonable. The effects of other factors which were not considered (some of which are hydraulic forces on the control plates and allowances and tolerances of fabrication and installation of the control region components) should also be evaluated before selecting the flow rate through the control region. Heat transfer and galvanic action between dissimilar metals of mechanical joints should also be evaluated. (auth)

18979 (GAMD-1049) SIMPLIFIED METHOD FOR CORE THERMAL DESIGN. J. T. Rogers (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nov. 17, 1959. Contract AT(04-3)-187. 32p. (MGCR-RE-122; MA-S89-1)

A method is developed for the thermal design of reactor

cores which minimizes or eliminates trial and error calculations. The method should prove useful for core parameter studies and for preliminary design calculations. It provides a rapid evaluation of the effects of variations in the factors affecting core thermal performance. (auth)

18980 (CRGP-1005) PROMPT POISON MEASUREMENT IN NRU. J. S. Geiger and R. L. Clarke (Atomic Energy of Canada Ltd., Chalk River, Ont.). Feb. 1961. 12p. (AECL-1203)

The prompt change in the reactivity of the NRU reactor that accompanies a 37-Mw change in its power (49 Mw \rightarrow 11 Mw \rightarrow 47 Mw) was deduced from reactivity measurements made at the reactor on November 6, 1958. The observed reactivity change, corrected for the xenon poison and photoneutron transients and for temperature change as measured by the heavy-water inlet temperature was -0.036 mk_{eff}/Mw. Later values for the NRU prompt-poison reactivity coefficient were -0.023 mk_{eff}/Mw deduced from uncorrected reactivity results for a 95-Mw power change (125 Mw \rightarrow 30 Mw), and -0.030 mk_{eff}/Mw, the value adopted by the NRU reactor staff for their reactivity calculations. (auth)

18981 (HW-67395) PLUTONIUM RECYCLE TEST REACTOR GAS LOOP ANALYSIS. W. D. Cameron (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 1961. Contract AT(45-1)-1350. 53p.

A study was made to determine the transient response of the Plutonium Recycle Test Reactor (PRTR) Gas Loop using automatic control. The results of the analog study, recommended controller settings and computer techniques used in studying the system are presented. Data indicated that the system, using the recommended controller settings, will be stable. A reactor scram would introduce sizeable temperature transients into the loop, but the temperature would decrease at the prescribed rate after the transients expired. Controller failure would decrease the gas temperature. A description of the system and the analog simulator is included. (M.C.G.)

18982 (IOP-4) REACTOR IRRADIATION AND EXAMINATION FACILITIES AT CHALK RIVER: BRIEF DESCRIPTIONS AND RENTAL CHARGES. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Feb. 1961. 25p. (AECL-1076)

Brief descriptions of the NRX and NRV reactors are given together with their associated research and examination facilities. Also included are the charges for using them. (M.C.G.)

18983 (MIL-STD-711(SHIPS)) MILITARY STANDARD RADIOACTIVE DECONTAMINATION OF NAVAL NUCLEAR POWER PLANT COMPONENTS. (Bureau of Ships). May 8, 1959. 21p.

Standard methods are outlined for decontaminating components, except fuel elements, removed from naval nuclear power plants and contaminated by exposure to reactor coolant water. Chemical, ultrasonic, and mechanical methods are considered. (D.L.C.)

18984 (NDA-2131-25) THE PAWLING LATTICE TEST RIG DESIGN REPORT. P. Anthony, S. Davis, R. Schamberger, and J. Hutton (Nuclear Development Corp. of America, White Plains, N. Y.). Apr. 24, 1961. Contract AT(30-1)-2303(IX). 91p.

The Pawling Lattice Test Rig (PLATR) was designed and fabricated and is operational in the existing NDA Pawling Research Reactor. PLATR is a D₂O-moderated system in which a variety of lattice parameters is measured using small samples of natural uranium lattice configurations. Operational progress, the proposed experimental program,

a detailed description of the design, performance characteristics, and operating procedures are outlined. The neutron spectrum incident on a test lattice cell can be adjusted to simulate that which would occur on a lattice in an infinite array of similar cells. The infinite multiplication factor is then determined by measuring the amount of absorber which, when substituted for a voided test cell, will reduce the multiplication factor to unity. (M.C.G.)

18985 (ORNL-3092) STUDY OF CAUSES AND PREVENTION OF HARD CAKE FORMATION DURING OUT-OF-PILE CIRCULATION OF AQUEOUS THORIUM OXIDE SLURRIES. C. S. Morgan (Oak Ridge National Lab., Tenn.). May 9, 1961. Contract W-7405-eng-26. 58p.

Occasionally, hard, intractable ThO₂ deposits formed on surfaces of the containing system during circulation of aqueous ThO₂ slurries at high temperature. Although entire surfaces of systems were coated with $\frac{1}{4}$ - to $\frac{1}{8}$ -in.-thick thoria deposits, cake formation was usually localized, forming preferentially in the pump impeller. Frequently, impeller deposits accelerated bearing failure. Cake formation was usually accompanied by formation of equal dense spherical aggregates 5 to 60 μ in diameter which remained suspended in the slurry. Caking and sphere forming phenomena, as investigated by tests of slurry properties in the laboratory and in a 30-gpm slurry loop, are described, as are methods for preventing caking. Thoria cakes and spheres are believed to form by reagglomeration of small particles or fragments worn or chipped off the larger thoria particles composing the initial slurry. It is thought that small fragments are forced over each other by the shear stress into positions of minimum energy where they are held together by van der Waals' forces. Thoria solubility is not believed to be an appreciable factor in cake or sphere formation. The extent of chemical bonding in the deposits is not clear. Greatest cake-forming tendency was noted in thoria prepared by calcination of Th(C₂O₄)₂ at 800°C, though cakes did occur with other ThO₂ preparations. Deposits formed from oxide batches that contained particles more resistant to degradation were softer, apparently because there were fewer fine fragments. A deposition preference between different metal surfaces as well as between different velocity sections was noted. Cake formation by fresh batches of thoria, that is, slurry in which the initial oxide particles were not made finer by previous circulation, is prevented by any factor which reduces particle comminution. Cake formation is avoided if particles are too resistant to degradation or if they degrade rapidly to intermediate-size particles. Intermediate-size particles, 0.1 to 0.5 μ , apparently do not yield fine fragments readily because of the reduced shear forces which are acting on smaller particles. Improved particle integrity can be accomplished by the method of oxide preparation, for example, the use of high calcining temperature or long digestion time. Cake formation by fresh oxides is also prevented by the addition of small quantities of surface-active electrolytes to the slurry. Effective electrolytes tested included CrO₃, NaAlO₂, Na₂SiO₃, and MoO₃. The electrolytes are thought to be effective by means of reducing particle fragmentation. Prevention of cake formation by slurries already containing particles in the caking-size range (e.g., a slurry composed of spheres produced during circulation) is more difficult, because agglomeration of the fine particles must be prevented. Lithium sulfate tended to reduce cake formation but was not completely effective. Other electrolyte additives tested (CrO₃ and NaAlO₂) failed to hinder cake formation during ThO₂ sphere circulation. (These spheres were "loop produced" in a previous slurry circulation experiment.) However, after extended circulation

during which partial dispersion of the spheres took place, cake formation was almost absent. It is postulated that the very fine particles wearing off the spheres gradually agglomerate into particles which are too large to form cakes but so small that fine particles or fragments are not worn off readily. Autoclaving of fresh thoria in water or dilute acids did not strengthen the particles sufficiently to prevent cake formation. Cake formation did not occur when the loop circulation temperature was reduced to 45°C. Extremely low thoria concentration did not deter cake formation. The integrity of loop-produced spheres was greatly improved by a combination of chemical and thermal treatment but was not improved sufficiently to prevent cake formation. Cake deposited in a ThO₂-circulation system is partially destroyed by thermal cycling and can be removed by circulation of a noncaking slurry. Particle integrity of the thoria was increased by coprecipitating small quantities of a second metal oxide with the ThO₂. The relation of zeta potential and slurry properties frequently appeared anomalous. Thoria deposition on metal plates suspended above rapidly rotating Waring Blendor blades was influenced by electrolyte additives and to a limited extent by a potential applied to the plate. The settled-bed concentration of slurries in quartz tubes at elevated temperature was sometimes influenced by electrolyte additives but varied with time at temperature. (auth)

18986 (TID-8210) CURRENT OUTSTANDING REACTOR PHYSICS PROBLEMS. (Advisory Committee on Reactor Physics, AEC). May 1961. 30p.

A reappraisal of outstanding reactor physics problems is presented. Outstanding problem classes in theoretical reactor physics are estimates for the errors to be expected in applying various methods, derivation of useful physics data from operating power reactor systems, and studies of machine methods. Specific problems in theoretical physics are: the theory of epithermal migration; theoretical estimation of reactor lifetime, power, and reactivity changes associated with burnup; resonance capture; neutron thermalization; methods for coupling nuclear, thermal, and hydraulic behavior of reactors; theory of thin regions; spatial distribution of thermal and resonance flux; simplified methods of calculating control rod characteristics; programming theory of control rods and of fuel management; pulsed assembly theory for multiplying systems in the far subcritical region; methods for dealing with xenon; and burnable poisons. Outstanding experimental problem classes include development of technique, specification of properties of intermediate spectra, and burnup in operating reactors. Specific problems include neutron slowing down distributions, thermalization studies, measurements of resonance capture, measurements of individual contributions to temperature coefficients, effects of gaps, voids, and other anisotropic regions, neutron spectra and slowing down times measurements, multiplication of fission neutrons in Be, inhour equation for reactors with delayed photoneutrons, and yields of delayed neutrons. Problems for specific reactor systems are also discussed. (M.C.G.)

18987 (TID-12551) QUARTERLY PROGRESS REPORT TO JOINT U.S.-EURATOM RESEARCH AND DEVELOPMENT BOARD ON BATTELLE ASSISTANCE TO AEC-EURATOM PROGRAM FOR THE PERIOD ENDING MARCH 31, 1961. Harold M. Epstein and Donald L. Keller (Battelle Memorial Inst., Columbus, Ohio). Contract W-7405-eng-92. 14p.

Void Distribution and Heat Transfer Studies. Steam distribution studies were made in 50- and 100-mil thick rectangular channels at pressures of 700 to 1300 psi and

Reynolds numbers of 4×10^4 to 10^5 . Correlations of slip ratio at constant void fraction indicates that the slip ratio has a maximum at a Reynolds number of ~75,000 and decreases monotonically with pressure. Development of Uranium Mononitride. It was found that UN specimens of 95 to 96% theoretical density can be prepared by hot pressing coarse UN powders at ~1480°C. A small amount of an extraneous phase was discovered in this dense UN by etching. Preliminary corrosion data are presented for UN. In arc melting studies, it was found that arc current and potential are important in the formation of UN by arc melting. Capsules were designed for irradiation studies of UN, and estimated rates of U burnup and H₂ production are given. Pellets of UN containing natural U were immersed in NaK in an Al container in a He atmosphere; after 1000 hr at 500°F, some discoloration of the UN specimen resulted (D.L.C.)

18988 (VDIT-36) LOOPS IN THE SAVANNAH RIVER-SHIPPIGPORT-AND PLUTONIUM RECYCLE TEST REACTOR PLANTS. A Literature Survey. Ernst Bock (Aktiebolaget Atomenergi, Stockholm). 1960. 10p.

A bibliography with abstracts is presented on the loops in the Heavy Water Components Test Reactor, Shippingport Pressurized Water Reactor, and Plutonium Recycle Test Reactor. Twenty-two references are given. (M.C.G.)

18989 (WCAP-1745) THERMOELECTRIC NUCLEAR FUEL ELEMENT QUARTERLY PROGRESS REPORT, JANUARY-MARCH, 1961. G. R. Kilp, W. P. Blankenship, K. J. Gill, R. C. Goodspeed, P. V. Mitchell, and E. G. Schwartz (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). Apr. 10, 1961. Contract AT-(30-3)-500. 21p.

Five uranium compounds were prepared by vapor-solid reaction of powdered U metal with S or Se. A swaged device containing USe_{1.00} is ready for thermoelectric measurements. A new vacuum welding chamber is being readied for sealing a number of uranium compounds in tantalum and molybdenum bombs for melting experiments. Improved techniques are being applied to measurements of resistivity and thermal conductivity of thermoelements. Three bench tests of PbTe couples are in progress. The pellet measuring apparatus is being improved for application at higher temperatures. An irradiated capsule containing PbTe pellets was removed from ETR on March 6, 1961. Because of instrumentation malfunction, a swaged PbTe couple was removed from WTR after the March 5 shutdown. Two other in-pile tests are being prepared. Nine elements were constructed using a swageable, anhydrous insulating material, AISIMag 222, which was adopted to replace the Lavite insulation for thermoelements. Better encapsulation and swaging techniques are being sought for element fabrication. A new cored pellet die was procured for pressing larger size thermoelectric wafers, permitting realization of improved cascading and instrumenting techniques. Dimensional optimization calculations for thermoelectric couples in a thermoelectric reactor design indicated a potential improvement in efficiency from 6.0 to 8.7%. Among the advantages seen for a spherical core configuration are that it could be designed to operate with the thermoelectric efficiency independent of reactor hot channel factor. (auth)

18990 (CEA-tr-X-215) EFFET DES PERTURBATIONS DE LA RADIOACTIVITE SUR LA DENSITE DES NEUTRONS UN REACTEUR NUCLÉAIRE. (Effect of Perturbations of the Radioactivity on the Neutron Density in a Nuclear Reactor). B. Cimblaris. Translated into French from Anais acad. brasil. cienc., 29: 535-43(1957). 21p.

An arbitrary perturbation of the reactivity in a critical

homogeneous nuclear reactor without a reflector causes a perturbation in the neutron density. These perturbations can be represented by a complex Fourier series, and various relationships are derived. Such cases as perturbations with the third harmonic, sinusoidal perturbation, phase difference, effect of the third harmonic, and the extension of some of the results of Langsdorf are treated. (J.S.R.)

18991 CONTRIBUTION TO THE STATISTICAL ANALYSIS OF HOT CHANNEL AND HOT SPOT FACTORS. F. Lerda and C. Rossi (FIAT, Turin, Italy). *Energia nucleare* (Milan), 8: 169-77 (Mar. 1961). (In English)

In order to investigate the statistical method of attack for hot spot and hot channel calculations, a rigorous definition of these factors is given and different methods of decomposition are analyzed. Starting from the Fermi reactor calculations by APDA, the possibility of linearization is investigated and extended to the Yankee type reactor. Comments on further developments are presented. (auth)

18992 HEAVY WATER REACTORS COOLED WITH LIGHT WATER-VAPOR MIXTURES. M. Silvestri (CISE, Segrate, Italy). *Energia nucleare* (Milan), 8: 209-12 (Mar. 1961). (In Italian)

Qualitative considerations on the general economy of heavy-water moderated, natural uranium fueled reactors show how important the choice of the coolant is. A light steam-water mixture cooling seems to be most promising because such a coolant is a very good approximation to an ideal one: the problems involved in the understanding of some basic phenomena are reviewed, with particular emphasis on heat-transfer, hydrodynamics, and corrosion and erosion problems. (auth)

18993 CRITICALITY CONDITION FOR BARE HOMOGENEOUS SPHERICAL REACTOR IN VELOCITY DEPENDENT P_L APPROXIMATION. Shin Yabushita (Kyoto Univ.). *J. Atomic Energy Soc. Japan*, 3: 163-7 (Mar. 1961). (In Japanese)

The criticality condition is derived for a bare homogeneous reactor in a velocity dependent P_L approximation, where the velocity dependence is approximated by Tschebyscheff polynomials. The criticality condition is expressed in the form of a determinant equal to zero. The numerical calculation is not carried out. (auth)

18994 VOID REACTIVITY RESPONSE IN BOILING WATER REACTORS. Tsutomu Kanai, Toshio Kawai, and Rei Aoko (Central Research Lab., Hitachi, Ltd., [Japan]). *J. Atomic Energy Soc. Japan*, 3: 168-78 (Mar. 1961). (In Japanese)

In order to analyze void reactivity responses caused by disturbances of inlet water velocity, inlet water temperature, system pressure, and reactor power, the "void equation" is derived from the fundamental equations of mass and energy conservation and the assumption of "slip ratio". This void equation is expressed as $(\partial f / \partial t) + U(\partial f / \partial z) = q$, where f = void volume fraction, t = time, z = length along a channel, U = "void transmission velocity", and q = effective heat source including the effect of system pressure changes. A "negative void" is introduced to treat reactivity responses caused by water temperature changes in the subcooled region, in the same manner as in the analysis of the boiling region. The void equation is applied to analyze kinetic behavior of a typical power reactor and its numerical solution is obtained. The linearized void equation is also derived and the void reactivity response diagram is obtained instead of the ordinary one using the "void map". (auth)

18995 INSPECTION OF PRIMARY CIRCUITS AND REACTOR PRESSURE VESSELS OF NUCLEAR POWER

PLANT. H. N. Pemberton and E. Crossley (Lloyd's Register of Shipping). *J. Brit. Nuclear Energy Conf.*, 6: 79-94 (Apr. 1961).

Inspection of the pressure parts of British gas-cooled power reactors is outlined and discussed. Reference is also made to steel containment pressure vessels. The main problems presented by reactor pressure parts are associated with the large size and also site fabrication. Periodic inspection is restricted to date to those parts that do not emit dangerous radiations. While contamination of other parts by radioactive dusts introduces another limitation, experience over four years at Calder Hall has shown that components on the heat-exchanger side of the stop valve can be efficiently examined. The need for extension of periodic inspection to the remaining circuit components of gas-cooled nuclear-power plants is emphasized. Reference is made to the need for radical improvement in leak tightness of circuits. Also of the desirability of maintaining simplicity and including essentials only in new specifications or codes of practice for reactor pressure-vessels and circuit components. (auth)

18996 STRESSES IN REINFORCED CONCRETE SHIELDS FOR NUCLEAR REACTORS. William Bonsall (U.K.A.E.A. Risley, Lancs, Eng.). *J. Brit. Nuclear Energy Conf.*, 6: 128-37 (Apr. 1961).

The thermal stresses in a slab of reinforced concrete, with a temperature distribution dependent only on distance into the slab, are analyzed. Shrinkage stresses, creep, and variation of physical properties with temperature are neglected. It is shown that, in a slab which is constrained to stay flat, a temperature difference of about 50°C can be allowed with only a nominal amount of reinforcement to control cracking. On the other hand, if the temperature difference is greater than about 87°C, then either the steel or the concrete must be stressed beyond the usual working limits (say 18,000 and 1,000 lb/in.², respectively). The economics of the alternatives of either allowing a temperature difference of 87°C in a concrete radiation shield, with the attendant necessity for heavy reinforcement, or reducing the temperature difference to 50°C by means of a suitable "thermal shield", are examined in an elementary fashion. It is decided that the thermal shield is probably the cheaper solution when the incident radiation warrants it. (auth)

18997 IRRADIATION TECHNIQUES FOR FISSILE MATERIALS. [PART] III. O. S. Plail (Atomic Energy Research Establishment, Harwell, Berks, Eng.). *Nuclear Power*, 6: No. 59, 100-2 (Mar. 1961).

Techniques for canning and heating fissile samples for in-pile irradiation purposes are discussed. The canning method employs double stainless steel cans, with a zirconium shield to prevent sample-can alloying and a molten sodium heat transfer element. An immersion heater is described for use up to 1000°C; the design of the heater cable is examined. Gas gap effects are studied. These techniques are used in DIDO. (T.F.H.)

18998 IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTORS AND FUEL ELEMENTS THEREFOR. Heinrich Hugo Ludolf Ritz and Edward Rae Elliott (to C. A. Parsons & Co., Ltd.). *British Patent* 866,049. Apr. 26, 1961.

A reactor is described in which helically-finned cylindrical fuel elements are stacked in tubular channels. Longitudinal flat baffles of the same length as the fuel element are distributed around the outside of the cylinder; the baffles extend further outward than the fins. The baffles are designed such that, under reactor operating temperatures, the baffles come into contact with the wall of the

moderator channel. This contact gives resistance to bowing and buckling. It is noted that the baffles may be made of graphite. (T.F.H.)

18999 IMPROVEMENTS IN DEVICES FOR COOLING THE CONTROL RODS OF NUCLEAR REACTORS. (to Commissariat à l'Energie Atomique). British Patent 866,254. Apr. 26, 1961.

A method for gas cooling reactor control rods is described. The control-rod channel has a larger diameter in the center of the reactor than at the ends, so that more gas may circulate around the control rod. This bulge in the channel is needed because of the usually higher neutron flux and corresponding control rod heat evolution in the center of the reactor. A plug is provided such that raising the control rod to its highest position stops the flow of gas through that particular channel. (T.F.H.)

19000 IMPROVEMENTS IN OR RELATING TO SERVICING EQUIPMENT FOR NUCLEAR REACTORS. Robert Tait, Robert Hugh Hall, and Charles John MacFarlane (to United Kingdom Atomic Energy Authority). British Patent 866,301. Apr. 26, 1961.

A reactor servicing device is described consisting of a cylindrical casing that contains a television camera, a tool holder in front of the camera, and a means for rotating the tool holder. The camera is mounted eccentrically in the casing, so that cables for operating tools may be passed through the opening between casing and camera. The tool holder is operated by a motor in the casing behind the camera. An outline is given of means for raising and lowering the device, and of grabs and other tools used in the device. (T.F.H.)

19001 IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTORS. Albert Colin Hughes (to Hawker Siddeley Nuclear Power Co., Ltd.). British Patent 866,305. Apr. 26, 1961.

A reactor control device is described in which a neutron poison, liquid or solid, undergoes a change to the vapor phase at a predetermined danger temperature. The change of phase increases the surface-to-mass ratio of the poison, thereby reducing the reactivity of the reactor. The poison may be contained within a hollowed fuel element or in the moderator; if Hg is used as a poison, a container is provided that will not rupture until the Hg pressure has built up to the danger temperature value. Means are provided for removal of the poisoned elements. (T.F.H.)

19002 IMPROVEMENTS IN OR RELATING TO SUPPORTING STRUCTURES. Michael Bayer (to General Electric Co., Ltd.). British Patent 866,306. Apr. 26, 1961.

A supporting structure which prevents relative movement between two parts in a nuclear reactor is described. The structure comprises a plurality of cranks pivotally connected to the frame and core through a radial link in such a manner that relative radial movement between the core and the frame causes pivotal movement of the crank. A coupling means is provided for interconnecting the arms of the cranks in such a manner that they are constrained to follow a similar pivotal movement in synchronism. (N.W.R.)

19003 IMPROVEMENTS IN OR RELATING TO PLANTS INCLUDING NUCLEAR REACTORS. Anthony James Taylor and Norman George Worley (to Babcock & Wilcox, Ltd.). British Patent 866,316. Apr. 26, 1961.

The described process relates to plants containing a gas cooled reactor in which the coolant, after being heated in the reactor, is arranged to heat a vapor generator and sub-

sequently an economizer before being recirculated. One valve with four outlets is used so that control is more satisfactory. Such a valve called for rearrangement of the piping system. Fluid from the separator drum is circulated at a variable rate through the economizer to adjust the temperature of the coolant entering the reactor. This allows the coolant temperature to be adjusted for the falling reactor load, avoiding shut-down in many cases. By elevating the coolant inlet temperature, the life of the uranium metal fuel elements is prolonged. (N.W.R.)

19004 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENT DISCHARGING ARRANGEMENTS. Everett Long and Ivor Kent (to United Kingdom Atomic Energy Authority). British Patent 866,541. Apr. 26, 1961.

A design is presented for receiving and storing fuel elements discharged from the core of a nuclear reactor by a discharge from the core of a nuclear reactor by a discharge machine. The storage facility is comprised of a discharge passage adapted to extend from the charge face of the reactor outwardly through the reactor containment. A shielded enclosure outside the reactor containment and into which the outer end of the passage projects is also described. A movable carriage, disposed within the enclosure, has a plurality of fuel element storage holes that may be moved to register in turn with the outer end of the discharge passage. The carriage is rotatable within the enclosure about a fixed axis and the storage holes are disposed annularly about the axis. The enclosure is fluid-tight and circulation of coolant through storage holes in the carriage is provided. An unloading passage disposed remotely from the discharge passage is provided, one end extending to an inspection and uncoupling cave and the other end projecting into the enclosure at a position such that the storage holes can be made to register in turn. The discharge passage is provided with a valve which allows coolant to pass from the storage hole to the discharge passage and along the passage for cooling a fuel element in transit from the discharge machine to the storage facility. (N.W.R.)

19005 IMPROVEMENTS RELATING TO THE MANUFACTURE OF NUCLEAR FUEL ELEMENTS. John Albert Robinson and Thomas Raine (to A.E.I.—John Thompson Nuclear Energy Co., Ltd.). British Patent 866,554. Apr. 26, 1961.

A method is presented for manufacturing finned cylindrical canning for reactor fuel elements. Hollow cylinders of the canning material, either Al or Mg, are pressed radially inward by dies distributed around the cylinder. Alternatively the fins may be formed by outward forcing of the canning material into the die or dies. The dies are shaped such that either circumferential, longitudinal, or helical fins may be formed, with longitudinal vanes. (T.F.H.)

19006 IMPROVEMENTS IN OR RELATING TO CONTROL MEANS IN NUCLEAR REACTORS. Wilfred Smith (to Hawker Siddeley Nuclear Power Co., Ltd.). British Patent 866,644. Apr. 26, 1961.

A reactor is described that has a reservoir of a liquid (e.g., Hg) that has a high thermal neutron absorption cross section (σ). Annular channels, capillary tubes, or other means are provided such that a rise in reactor temperature above a given temperature, T , causes the poison liquid to enter the channel or tube; the resultant rise in the surface-to-volume ratio of the liquid causes a drop in the reactivity, so the temperature returns to T . A second liquid with low σ may be used to push the poison liquid into the annular channel. (T.F.H.)

19007 IMPROVEMENTS IN OR RELATING TO COOLING SYSTEMS FOR NUCLEAR REACTORS. Sydney Fawcett and Robert James Haslam (to United Kingdom Atomic Energy Authority). British Patent 866,782. May 3, 1961.

A graphite-moderated reactor is described that has closely fitting sleeves in its fuel element channels. The gap between sleeve and channel is filled with a static heat transfer medium, e.g., He. A second sleeve may be inserted inside the first sleeve and around the fuel elements, to form a re-entrant cooling system. This fuel-channel design allows preferential cooling of the graphite near the fuel, with improved neutron absorption and Wigner energy properties. (T.F.H.)

19008 IMPROVEMENTS IN OR RELATING TO NUCLEAR ENERGY REACTOR STRUCTURES. (to Gustav Stahlwerk Witten A. G.). British Patent 867,097. May 3, 1961.

Steel for nuclear reactor structures exposed to neutron irradiation; made from ferritic, pearlitic, or austenitic or alloy steel; is described. The steel is boron-free and consists of at least one alloying element having a macroscopic absorption cross section for thermal neutrons of 0.02 cm^{-1} or less. The total amount of the alloying element is limited within the range 0.5 to 10% by weight. The chemical element or elements may be beryllium and/or zirconium (hafnium-free). The carbon content may lie within the range 0.02 to 2.1% by weight and the silicon content may be up to 1% by weight. (N.W.R.)

19009 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR MODERATOR STRUCTURES. Stanley Hackney (to United Kingdom Atomic Energy Authority). British Patent 867,224. May 3, 1961.

A graphite moderator structure for a gas cooled thermal reactor is described. The structure is made up of right prismatic blocks of basically rectangular cross section, stacked in the form of a rectangular lattice in columns abutting on their side faces and having fuel element channels in the direction of the axes of the columns. The directions of minimum Wigner growth in the blocks are perpendicular to the axes of the fuel element channels and are set in a pattern so that the side faces of the blocks are recessed to accommodate maximum growth. (N.W.R.)

Power Reactors

19010 (AE-49) PRESSURE TUBE AND PRESSURE VESSEL REACTORS; CERTAIN COMPARISONS. P. H. Margen, P. E. Ahlström, and B. Pershagen (Aktiebolaget Atomenergi, Stockholm). 1961. 43p.

In a comparison between pressure tube and pressure vessel type reactors for pressurized D_2O coolant and natural uranium, one can say that reactors of these two types having the same net electrical output, over-all thermal efficiency, reflected core volume and fuel lattice have roughly the same capital cost. In these circumstances, the fuel burn-up obtainable has a significant influence on the relative economics. Comparisons of burn-up values made on this basis are presented and the influence on the results of certain design assumptions are discussed. One of the comparisons included is based on the dimensions and ratings proposed for CANDU. Moderator temperature coefficients are compared and differences in kinetic behavior which generally result in different design philosophies for the two types are mentioned. A comparison of different methods of obtaining flux flattening is presented. The influence of slight enrichment and other coolants (boiling D_2O and gases) on the comparison between pressure tube and

pressure vessel designs is discussed and illustrated with comparative designs for 400 Mw electrical output. (auth)

19011 (AEPSC-641) ECNG-FWCNG—PROTOTYPE POWER PLANT GAS-COOLED REACTOR PROJECT. Progress Report No. 5. (American Electric Power Service Corp., New York). Mar. 15, 1961. 156p. For East Central Nuclear Group and Florida West Coast Nuclear Group. Contract AT(38-1)-200.

The development and application of the ECNG-FWCNG gas-cooled, heavy-water-moderated, pressure-tube-type reactor concept are reported. Effort was devoted toward obtaining a fixed price bid on the design and construction of the prototype plant. Studies of the effect of CO_2 pressure drop on plant performance and equipment costs were completed. The over-all plant control studies were advanced by the mathematical simulation of the steam cycle. Preliminary analog diagrams for the various steam cycle components were developed. Designs of the CO_2 and D_2O systems were augmented to provide safe shutdown of the reactor in the event of loss of all normal a-c power supplies. The electrical system was revised to accommodate emergency power requirements in the event of such an incident. A tentative blower shaft seal testing program was developed to determine reliability and operating characteristics of the proposed seal design. The containment diameter and over-all height were increased. (M.C.G.)

19012 (AGN-TM-383) ARMY GAS-COOLED REACTOR SYSTEMS PROGRAM. CONCEPTUAL DESIGN STUDY, 3000 kw(e) MOBILE NUCLEAR POWER PLANT. H. C. Carney, Jr. (Aerojet-General Nucleonics, San Ramon, Calif.). Apr. 1961. Contract AT(10-1)-880. 78p.

A 3000 kw(e) mobile nuclear power plant consisting of a nitrogen-cooled reactor and a regenerative closed-cycle gas turbine power conversion system operating at a maximum pressure of 500 psia is described. A net plant efficiency of 18.4% is achieved with a turbine inlet temperature of 1300°F and an ambient temperature of 100°F . The entire system is readily transportable; the plant is divided into seven individual packages, each weighing less than 15 tons. The total plant weight is approximately 100 tons, corresponding to 67 lb/kw of net electrical output. A medium-sized, mobile power plant appears to be feasible both technically and economically. The design is intended to fulfill requirements for electrical power at remote locations where the logistics or economics of maintaining a conventional power plant is prohibitive, or at sites where the presence of exhaust fumes is intolerable. (auth)

19013 (CF-60-12-5(Rev.)) DESIGN STUDY OF A PEBBLE-BED REACTOR POWER PLANT. A. P. Fraas, R. S. Carlsmith, J. M. Corum, et al. (Oak Ridge National Lab., Tenn.). May 11, 1961. Contract W-7405-eng-26. 150p.

A conceptual design study of a 330-Mw(e) pebble-bed reactor was completed. Emphasis was placed on the application of the pebble-bed reactor to a large central station. The characteristics of both axial and radial flow were evaluated. The effects of various limitations associated with the fuel temperature, pressure-vessel fabrication problems, the pumping power-to-heat removal ratio, graphite shrinkage cracking, thermal stresses in the fuel spheres, the core conversion ratio, the core length-to-diameter ratio, and fuel cycle costs were considered. A reactor with a 20.5-ft-diameter upflow core was chosen for the study. Results indicated that the higher allowable fuel element temperatures permissible with an all-graphite-uranium carbide reactor make possible a net thermal efficiency of about 40%. Capital costs were calculated to be

\$190/kw. Preliminary estimates indicated that fuel cycle costs are likely to be from about 2.2 to 5.5 mills/kw hr. (M.C.G.)

19014 (CF-61-3-86) SUMMARY OF HRT RUN 19. H. F. Bauman, N. C. Bradley, J. R. Engel, and P. N. Haubenreich (Oak Ridge National Lab., Tenn.). Mar. 16, 1961. 27p.

During a startup on February 5, 1959, at the beginning of Run 19, the blanket circulating pump impeller (titanium) ignited and was severely damaged. On the same date, a power lead failed on the fuel circulating pump and, in the repair, the pump was inadvertently rewired so that it ran in reverse. Abnormally low circulation rates resulted. Temporary pressure taps and an orifice flowmeter were installed and used to investigate the cause for the low flows. The blanket pump was replaced and the damaged impeller was examined. During the next startup, on May 8, the fuel circulating pump impeller apparently ignited. This pump, too, was replaced in preparation for Run 20. Most of the time during Run 19 was spent in necessary maintenance, preparations for flow and pressure drop measurements and low-temperature tests on the system. The reactor was critical for 18 hours. (auth)

19015 (CF-61-3-136) NUCLEAR CHARACTERISTICS OF POSSIBLE REPLACEMENT REACTORS FOR THE HRT. D. R. Vondy and M. Tobias (Oak Ridge National Lab., Tenn.). Mar. 28, 1961. 30p.

A study was made to establish the dependence of the nuclear characteristics on several variables for certain possible replacement reactors for the HRT. Two-dimensional, two-group, neutron diffusion calculations were made for arrangements appearing most feasible from one-dimensional, multigroup survey calculations. For a 21-in.-diameter, 200-liter core, reflected by a 4-in.-thick beryllium cylinder and contained in a 52-in. I.D. pressure vessel, the critical core concentration was found to be 5.0 gm U^{233} /l with no fertile material, and 6.6 gm U^{233} /l or about 10.0 gm U^{235} /l when loaded with a total of 4,000 Kg Th^{232} in the blanket. Associated maximum relative power densities were 6.2, 6.7, and 7.0 Kw/l/Mw, respectively, and core-wall relative power densities were 5.5, 5.6, and 5.2 Kw/l/Mw. The gross breeding ratio was estimated at 1.070 with no fuel in the blanket and 1.039 with 10 gm U^{233} /l in the inner fertile region. The relation between the accuracy of measurements of the conversion ratio and errors in measurement of fuel inventory is discussed. Estimates are made of the value of the true conversion ratio which would be required in order to show that a measurement of it exceeds a given amount. (auth)

19016 (CF-61-4-6) OPERATION OF THE EGCR PURIFICATION SYSTEM PROTOTYPE. R. E. MacPherson and A. M. Smith (Oak Ridge National Lab., Tenn.). Apr. 3, 1961. 20p.

Tests were conducted on an EGCR scale-model purification system to determine the effectiveness of the system in removing gaseous impurities from circulating helium. Results indicated that H_2 , CO, and CH_4 can be satisfactorily removed by oxidation in a catalytic converter. The gaseous oxygen added to the purification stream upstream of the converter is essentially completely removed by passage over the platinum catalyst bed. The ability of the purification system to remove CO_2 and H_2O by use of molecular-sieve and silica-gel absorbers and to satisfactorily control impurities generated by continuous water injection was demonstrated. (auth)

19017 (CF-61-4-62) MSRE PRELIMINARY PHYSICS REPORT. C. W. Nestor, Jr. (Oak Ridge National Lab., Tenn.). Apr. 19, 1961. 5p.

The results of reactor physics calculations for the currently proposed MSRE core design were compiled. The core was assumed to consist of a homogeneous mixture of fuel salt and graphite, with 22.5% of the core volume occupied by fuel; the salt composition was the currently proposed mixture of 70 mole % LiF, 23 mole % BeF_2 , 5 mole % ZrF_4 , 1 mole % ThF_4 , and UF_4 as required for criticality. The calculated critical mole %, assuming 93.5% U^{235} , was 0.2 mole % UF_4 ; the associated inventory of U^{235} in the circulating system was 45 kilograms. Mean core thermal flux was estimated to be 2.9×10^{13} n/cm² sec with an associated mean power density of 3.9 watts/cm³ for 10 megawatts total reactor power. (auth)

19018 (CF-61-4-63) TEMPERATURE TRANSIENTS DUE TO DENSITY CHANGES ON CHANGING POWER LEVEL IN THE HRT. M. L. Tobias and D. R. Vondy (Oak Ridge National Lab., Tenn.). Apr. 6, 1961. 9p.

Changing the power level in the HRT leads to small average density changes in the high-pressure system which produce noticeable changes in the nuclear average temperature. It is calculated that taking the reactor from zero power to 5 Mw in one-half hour leads to a temperature rise of $\sim 0.7^\circ C$, followed by a gradual fall over a two-hour period to $\sim 1.3^\circ C$ below the temperature at zero power. (auth)

19019 (CF-61-4-96) HRT MOCKUP RUNS CS-25 AND CS-26. J. E. Jones, Jr. (Oak Ridge National Lab., Tenn.). Apr. 26, 1961. 4p.

Two runs, CS-25 and CS-26, were carried out in the HRT Mockup to define permissible solution compositions for operation in the HRT. In Run CS-25, it was established that starting with 0.04 m UO_2SO_4 , 0.02 m $CuSO_4$ and 0.035 m H_2SO_4 , dilutions between 18- and 700-fold were unstable. It is necessary, therefore, to keep U concentration above 1 to 1.3 g per liter. In Run CS-26, it was shown that a solution of 0.030 m UO_2SO_4 , 0.015 m $CuSO_4$, 0.010 m $NiSO_4$ and 0.035 m H_2SO_4 could be circulated without excessive stainless steel corrosion. (auth)

19020 (DLCS-2430106) PERIODIC INTERCALIBRATION OF TEMPERATURE SENSING ELEMENTS. CORE I, SEED 2. Test Results (T-641303). (Duquesne Light Co., Shippingport, Penna.). First issue, Mar. 14, 1961. 58p.

Tests were conducted to determine the direction and magnitude of drift in core thermocouples, primary loop and pressurizer resistance thermometers, and the resistance thermometers in the secondary side of the boilers. The temperature sensing elements of the reactor coolant loops did not show any significant short-term error. The tests of the core thermocouples were not conclusive. Test data are included. (J.R.D.)

19021 (DLCS-2430108) PERIODIC CALIBRATION OF TEMPERATURE SENSING ELEMENTS. CORE I, SEED 2. Test Results (T-641303-B). (Duquesne Light Co., Shippingport, Penna.). First issue, Apr. 14, 1961. 36p.

Tests were conducted to determine the direction and magnitude of any short- or long-term drift in core thermocouples, primary loop and pressurizer resistance thermometers, and resistance thermometers located in the secondary side of the boilers for Seed 2 at 2303 EFPH. It was found that drift in the core thermocouples is definite but random. Other findings are discussed and calibration data are presented graphically. (J.R.D.)

19022 (DLCS-344102) RAPID STATION SHUTDOWN. CORE I, SEED 2. Test Results (T-643729). 761.3 EFPH. (Duquesne Light Co., Shippingport, Penna.). First issue, Apr. 14, 1961. 18p.

Tests were conducted to provide data on the dynamic characteristics of the Reactor Plant from which to deter-

mine its response to a rapid station shutdown, and to prepare the station for low power xenon transient physics testing. With the exception of the high T_h alarm on the 1B coolant loop the plant did not exceed the limitations in the operating guide and the plant was prepared for low power xenon transient testing. (J.R.D.)

19023 (DLCS-3440104) RAPID STATION SHUTDOWN. CORE I, SEED 2. Test Results (T-643729). EFPH 2247. (Duquesne Light Co., Shippingport, Penna.). First issue, Apr. 6, 1961. 12p.

A test was conducted to determine the dynamic response of the Shippingport Reactor plant to a rapid station shutdown, and to prepare the station for low power, xenon transient, physics testing. It was found that the plant was operated satisfactorily to absorb the effects of a rapid station shutdown from 66 to 0 Mw at an average rate of 0.83 Mw/sec. (J.R.D.)

19024 (DLCS-3620102) REACTIVITY LIFETIME. CORE I, SEED 2. Test Results (T-612118-C). 773.8 EFPH to 2246.8 EFPH. (Duquesne Light Co., Shippingport, Penna.). First issue, Mar. 13, 1961. 28p.

Tests were conducted to subject Core I Seed 2 to rapid reactivity depletion by operating the station at full power for extended periods of time in which pertinent plant operating data were collected to be used in core design and performance evaluation. The total number of EFPH during the test was 1473. The station operated at about 100% power for 1183 EFPH producing a gross of 67 Mw. (J.R.D.)

19025 (GA-1378) 40-MW(E) PROTOTYPE HIGH-TEMPERATURE GAS-COOLED REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report for the Period Ending March 31, 1960. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Apr. 1961. Contract AT(04-3)-314. 202p.

Activities in the research and development program during this quarter are discussed. From the fuel element cladding irradiation program it was learned that the permeation coefficient, the thermal conductivity, and linear dimensions of low permeability graphite are essentially unaffected by exposure to the reactor environment. The irradiation program was continued. One capsule for studying irradiation damage in fuel compacts is being evaluated; one is cooling following exposure in the GETR; and one is running in the test reactor. In addition, a capsule for studying the behavior of control-rod materials under reactor conditions is cooling following exposure. Detailed design of the in-pile loop facility is being carried out under sub-contract by the General Electric Vallecitos Laboratory. Consultation with suppliers of low-permeability graphite has continued. Samples for evaluation are being received routinely from suppliers both in this country and in England. A program to study the release of volatile fission products from graphite-matrix fuel bodies as a function of temperature and method of preparation was initiated. Alternative designs of the all-graphite fuel element, differing in the details of the purge flow within the elements, were examined. A design utilizing a countercurrent purge flow was identified, and future work will be concentrated on this design. Detailed design and planning work was initiated for the construction of a nonnuclear model of the reactor core with which problems of pressure drop, flow distribution, and general mechanical construction can be investigated. Information relevant to the HTGR program was obtained from other programs under way at Atomic Energy Commission laboratories. Also, preliminary conversations were held with the staff at the Winfrith Heath Laboratory in Great Britain on problems of mutual interest concerning high-

temperature gas-cooled reactors. Work to develop improved codes for calculating the properties of high-temperature graphite-moderated reactors has continued. Satisfactory progress on the construction of the critical facility is reported. Conceptual design work has continued on an actuator system for a pneumatic control-rod drive. Design work has continued on alternative arrangements of the fuel-handling equipment. Locating the storage pond for spent fuel elements at a level above the reactor core has several advantages, and this arrangement was adopted for the conceptual design of the prototype plant. With this arrangement, removal and loading of fuel elements is accomplished through the top head of the pressure vessel. Conceptual design work on the reactor pressure vessel has continued. Alternative patterns of coolant flow through the thermal shields within the vessel were examined, but it was decided to retain the original configuration. It was decided to accept as a design basis the use of two steam generators for the power plant, each having one-half the total required capacity. (J.R.D.)

19026 (GA-1640) 40-MW(E) PROTOTYPE HIGH-TEMPERATURE GAS-COOLED REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report for the Period Ending June 30, 1960. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Apr. 1961. Contract AT(04-3)-314. 219p.

The accelerated development program on the graphite-clad fuel element, initiated during the preceding quarter, was continued during this reporting period. The most significant development has come from the capsule-irradiation program. Three of the irradiated fuel capsules, containing a total of 18 fuel compacts, were evaluated during this period. The fuel compacts were exposed to a burnup of approximately 75% of the full HTGR lifetime. All 18 of the compacts were in excellent condition following the neutron exposure, and dimensional changes from the reference design of the compacts were less than 1%. A correlation between diametral shrinkage of the compacts and small fuel-particle size was observed. Full-size fuel compacts are now being produced by a warm-pressing and sintering process. The optimization of this process is under way. Samples of various kinds of low-permeability graphite continue to be received from outside suppliers and their properties are being evaluated. The helium permeabilities of these samples, in general, are in the range of 10^{-5} to 10^{-7} cm²/sec. Small samples of various kinds of base-stock graphite were impregnated, and the permeabilities after impregnation have been around 10^{-5} cm²/sec. Progress on the engineering of the in-pile loop continued. Detailed engineering is now 75% complete and components are being procured. Progress was made in the development of methods for calculating the scattering kernel and neutron spectrum in graphite. Some effort has been devoted to the evaluation of fast-neutron dosage to the pressure vessel and various components of the reactor core. Gamma-ray heating in the grid plate has been analyzed, and activation rates in the steel in the bottom shield have been calculated. The design of the half-scale, nonnuclear model of the reactor vessel, internal parts, and core has been essentially completed, and competitive bids have been received for fabrication of the model. Construction of the HTGR critical assembly was completed during this period. The initial experiment to be performed with the assembly is an evaluation of the control-rod worth in the HTGR. A full-size prototype of the pneumatic-stepping-motor control-rod drive unit was fabricated and tested. The motor was found to be operable and to perform in general as specified. Modifications to improve the smoothness of operation are

in progress. Preliminary design studies are being carried out on alternative control-rod drive mechanisms, the object being to find a drive mechanism which requires little head room beneath the reactor vessel and, consequently, permits the use of a smaller shield structure. Analyses of various alternative steam-generator designs were carried out, and a computer code was developed to study part-load performance of the steam generator. A strong effort was made to determine the most desirable materials for construction of tubes and other parts of the steam generator, and to provide satisfactory access for tube plugging. Development of the reactor-plant layout has continued. The use of expansion bellows in the primary-loop piping was investigated and found to allow a simpler and more compact layout of the primary system. (auth)

19027 (GAMD-702 & Suppl.) HTGR FISSION-PRODUCT TRAPPING SYSTEM—PRELIMINARY SYSTEM ANALYSIS AND SUMMARY OF FACTORS. T. H. Pigford (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Feb. 24, 1959. Supplement. Mar. 27, 1959. Contract AT(04-3)-314. 22p.

The functional effects of the system design of the HTGR fission-product trapping system is summarized. A sample steady-state case is examined, followed by an extension of the steady state to consider the effects of continuous cleanup of the primary coolant by flow through the trapping system and by flow through the external decontamination system. (auth)

19028 (GEAP-3649) LARGE HIGH POWER DENSITY CORE—INTERIM REPORT I: PHYSICS DESCRIPTION OF REFERENCE DESIGN. C. L. Miller (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Feb. 3, 1961. Contract AT(04-3)-361. 18p.

A large core design is presented which approximates recent technology and is intended as a starting point for development of the physics and technology related to the design of a 300-Mwe plant. The physics aspects of the design program include enrichment specifications, lattice geometry, and control methods. The information may be useful in evaluating the performance of future designs. (J.R.D.)

19029 (HPR-12) QUARTERLY PROGRESS REPORT, H. B. W. R., OCTOBER THROUGH DECEMBER 1960. (Norway. Institutt for Atomenergi. OEEC Halden Reaktor Prosjekt). 89p.

The test run of Oct. 5, 1960, demonstrated that the plant is ready for operation at power. Modifications of the system are described. A new valve and line in the feedwater circuit permits subcooling to be varied almost independently of steam load. An improved make-up water regulator stabilizes steam drum level and results in dryer secondary steam. The installation of seven spikes increased the net reactivity to 6.2% and permits operation at 5 Mw reactor power and 5 atm pressure. Measured zero power transfer functions agree with theory in both amplitude and phase. The measured temperature effect on void reactivity revealed a discrepancy in the theoretical treatment which may be resolved by use of the P-3 approximation. Equipment for operation at second charge (20 Mw) condition is described. The sequence of events in the approach to power beginning on Oct. 4, 1960 is given. (D.L.C.)

19030 (IDO-16675) ORGANIC COOLANT REACTOR PROGRAM. Quarterly Report, September 1–December 31, 1960. (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Contract AT(10-1)-205. 52p.

Programs for development of organic reactor technology are discussed. One phase of this work is a broad basic study of the fundamentals of radiolytic breakdown of or-

ganic materials leading eventually into the selection of new more resistant coolants, stabilization against radiation damage, and reclamation of deteriorated coolants. The other phase of the work is concerned with the operation and experimental program of the Experimental Organic Cooled Reactor (EOCR) now being constructed at the National Reactor Testing Station. In the work on organic coolant technology, equipment was readied and techniques developed. A 4-kw electron linear accelerator is being used for a source of high radiation dose rates (3×10^{10} r/hr) to screen organic samples. A calorimetric dosimeter and accompanying standard radiation cells were fabricated. A dynamic loop to provide simulated reactor temperature, pressure and flow conditions in the radiation cell is in operation. A similar loop is provided to study pyrolytic decomposition. Other static radiation cells for use on the accelerator were built to study the effect of additives on coolant stability. Two continuous flow high pressure catalytic hydrocracking units were put into operation in a study of reclamation of OMRE high boilers. In the study of fouling of heat transfer surfaces, irradiation of terphenyl samples containing iron particles gave indications of catalyzed polymer and film formation. Pyrolytic decomposition of Santowax on a hot filament was largely of the ortho- and meta-terphenyls forming high boilers in the quinquephenyl range. A group of typical aromatic heavy oils was assembled from petroleum refineries to be tested as suitable coolants. Some sixty possible radiation stabilizers against radiation damage were selected for testing. The synthesis of selected isomers of tetra-, quinque- and hexaphenyls was started. In connection with the EOCR, liaison assistance during construction was provided. A mechanical test facility was erected to test prototypes of the control rods and their drives which are being designed for the EOCR. It is expected to be in operation in March 1961. This facility will be valuable throughout the operation of the EOCR to proof-test hydraulically and mechanically standard and new fuel elements and control rods before insertion. Pre-operational tests, startup manuals, and operating procedures are being developed. Material is being assembled and calculations are underway for a final Hazards Summary Report which must be submitted 90 days before startup. Conceptual designs of an Organic Technology Loop and a Fuel Technology Loop for the EOCR were submitted. Detailed design of the former is underway. Development of in-pile experimental components was started. (auth)

19031 (KAPL-1144(Del.)) COMPACT REACTOR POWER PLANT WITH COMBINATION HEAT EXCHANGER—THERMOELECTRIC PUMP. E. A. Luebke and L. B. Vandenberg (Knolls Atomic Power Lab., Schenectady, N. Y.). July 7, 1954. Decl. with deletions Feb. 19, 1960. Contract W-31-109-eng-52. 19p.

A compact reactor power plant is described in which the reactor proper is located within a cylindrical heat exchanger. The pumping action in the liquid-metal-cooled system is obtained in combination with the heat exchanger function. By interposing thermoelements, a large thermoelectric current is generated in the heat exchanger by the temperature gradient normally existing between hot and cold tubes. With suitable pole pieces, the current produces a perpendicular magnetic field and develops sufficient force on the liquid metal for the desired pumping action. (auth)

19032 (NAA-SR-5369) DEVELOPMENT OF A VARIABLE ORIFICE FOR HNPf FUEL CHANNELS. C. J. Baroczy, J. A. Hagel, and W. D. Leonard (Atomics International. Div. of North American Aviation, Inc., Canoga

Park, Calif.). May 1, 1961. Contract AT-11-1-GEN-8. 30p.

Control of the exit temperature of the coolant from each fuel channel of the Hallam Nuclear Power Facility reactor is obtained by adjusting the coolant flow rate by a remotely operated variable orifice. Two variable orifices were designed and the hydraulic characteristics determined. Both orifice designs utilized a tapered plug moving in and out of a restricted flow passage at the upper end of the fuel channel. Data were obtained on pressure drop as a function of flow rate at different orifice plug positions; all measurements were made using water, and data were converted to equivalent values for sodium. Either type of orifice was capable of adjusting flow rate to match the power output of a fuel element at any location in the reactor core. The temperature sensitivity (change in exit temperature per unit change in orifice plug position) of the first type of orifice was low ($10^{\circ}\text{F}/\text{in.}$) when used in combination with a central fuel element, and high ($700^{\circ}\text{F}/\text{in.}$) when used with a peripheral element. The temperature sensitivity of the second type was more uniform (varying from 90 to $250^{\circ}\text{F}/\text{in.}$). Consequently, the second type of orifice was selected for the HNPF. (auth)

19033 (NDA-2131-36) HEAVY WATER-MODERATED POWER REACTOR PROGRAM. Monthly Progress Report for Period Ending April 30, 1961. (Nuclear Development Corp. of America, White Plains, N. Y.). May 10, 1961. Contract AT(30-1)-2303(IK). 11p.

The safety review of PLATR was completed and normal operation resumed. The movement of reflector material from the upper to the lower surface of the cover reduced the required upper leveler fuel loading substantially. Minor modifications were made in the reactivity prediction method to enable it to handle single rod lattices. As a result, the agreement with experimental values of buckling was improved, but not substantially. It is felt that the method breaks down for extremely heavily loaded lattices. (D.L.C.)

19034 (NOTS-TP-2582) SELECTED CHARACTERISTICS OF MARITIME NUCLEAR POWER SYSTEMS. Milton Neufeld (Naval Ordnance Test Station, Inyokern (China Lake, Calif.). Nov. 16, 1960. 10p.

The principal economic and physical characteristics of maritime nuclear power systems that might be used in cargo submarines in the 1970 to 1980 period are examined. Special emphasis is placed on the direct-cycle boiling water reactor in sizes ranging from 10 to 100 Mw(t) capacities. (auth)

19035 (SG-VAL-2(3rd Ed.)) GENERAL ELECTRIC VALLECITOS BOILING WATER REACTOR. Final Hazards Summary Report. J. L. Murray, ed. (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). Nov. 30, 1959. 334p.

Descriptions and evaluations are included of modifications to be made to the VBWR installation to obtain information contributing to the development of safer, more efficient and more economical boiling-water reactor power plants. Sufficient changes are proposed that the accident analyses have of necessity changed from those of previous editions, but analyses of the maximum credible accident and other severe hypothetical accidents are essentially unchanged. Other changes made reflect changes in plant design and procedures resulting from the modifications. All pertinent information describing the VBWR is consolidated including technical specifications, process description, facility description, instrumentation, operating procedures, site characteristics and description, safety analysis, waste disposal, and special experimental facilities. (B.O.G.)

19036 (TID-5762(Vol.I, Suppl.I)) SUPPLEMENTAL REPORT ON NEW PRODUCTION REACTOR; POWER PLANT ECONOMIC FEASIBILITY STUDY. (Federal Power Commission. Bureau of Power, San Francisco). Feb. 1961. 99p.

The results are presented of a study to reappraise the economics of adding power-producing facilities to the convertible reactor under construction at Hanford. Items especially considered included marketability of NPR power, cost and amount of power available from the NPR power plant and conventional sources, amount and cost of reserves required, and transmission facilities needed. Contained are a primary study based on estimated loads and resources deemed most likely to occur and a secondary study based on the sale by the summer of 1961 of an additional 400 Mw of power to industries resulting in an equal increase in loads. (B.O.G.)

19037 (TID-7604) SHAFT SEALS FOR COMPRESSORS AND TURBINES FOR GAS-COOLED REACTOR APPLICATION. Proceedings of Meeting at Oak Ridge National Laboratory, December 16-17, 1959. (Oak Ridge National Lab., Tenn.). 242p.

Twenty-five papers presented at a meeting at ORNL are given. A separate abstract has been prepared for each paper. (M.C.G.)

19038 (TID-7604(p.3-6)) WATER-BUFFERED SEAL DEVELOPMENT FOR THE EGCR. L. P. Carpenter (Kaiser Engineers Div., Henry J. Kaiser Co., Oakland, Calif.).

The features of the Experimental Gas Cooled Reactor and the design parameters involved in the development of the blower seal for the EGCR are outlined. The seals considered were designed to be used with variable-speed blowers driven by constant-speed motors through a variable speed drive. The criteria for the blower seal development program are: minimize loss of helium from the system, prevent contamination of the helium by the seal system, assure reliability of seal system, and consider seal and its auxiliaries as a system. (M.C.G.)

19039 (TID-7604(p.7-13)) WATER-BUFFERED SEAL DEVELOPMENT FOR THE EGCR. F. F. Szczesny (Allis-Chalmers Mfg. Co., Milwaukee).

Seal development was based on system requirements and compressor operating conditions. Three basic types of seal were considered: labyrinth, axial face, and bushing. Preliminary surveys showed that the bushing seal fulfilled the requirements of simplicity, reliability, and durability. It was found that a thorough test analysis of the seal would require the following cells: a low-pressure, low-temperature, hydrodynamic cell; a low-pressure, high-temperature cell; a complete high-pressure, high-temperature test cell with a purification system; and a concentricity cell. The functions of each cell are described. (M.C.G.)

19040 (TID-7604(p.14-24)) WATER-BUFFERED SEAL DEVELOPMENT FOR THE EGCR. K. E. Kraemer (Allis-Chalmers Mfg. Co., Milwaukee).

The bushing seal was evaluated for EGCR application. The inlet configuration for the introduction of the fluid into the buffering zone and the clearance-area characteristics was investigated. Attempts to eliminate completely the causes for eccentric pressure patterns were unsuccessful. The heat generated by viscous shear and dissipated or absorbed in the system was studied. A curve illustrating the thermal expansion characteristics of this type of seal system is included. (M.C.G.)

19041 (TID-7604(p.25-36)) STUDIES OF FLOATING BUSHING SEALS. W. K. Stair (Oak Ridge National Lab., Tenn.).

The blower seal design was investigated in order to determine leakage of sealant and process fluid, back diffusion of sealant into process fluid, seal ring support and restraint, and starting and stopping difficulties. The following factors were considered: thermal distortion, thermal alteration of clearances, manufacturing tolerances, compressor speed range, and frequent start-stop operations during initial reactor testing. (M.C.G.)

19042 (TID-7604(p.37-58)) OIL-LUBRICATED BUSHING SEAL WORK FOR THE MGCR. E. S. Dennison (General Dynamics Corp. Electric Boat Div., Groton, Conn.).

Seals and bearings for a blower and for prototype turbomachinery were developed. A bearing-and-seal test rig was designed and constructed. Carbon face seals were found to be unpredictable. Oil-lubricated bushing seals were developed. The oil pressure was controlled at a value nearly equal to the gas pressure. The amount of gas and oil mixture coming from the drain was controlled by an orifice downstream. The seal system appeared to be satisfactory in continuous operation, but during startup or shutdown, oil appeared in the interior of the container. The floating-seal bushing did not show wear. (M.C.G.)

19043 (TID-7604(p.59-67)) GCRE-I COMPRESSOR SEAL EXPERIENCE AND ML-1 SEAL PROBLEMS. W. H. Moore (Aerojet-General Nucleonics, San Ramon, Calif.).

The types of seals used in the Gas Cooled Reactor Experiment-I, a gas turbine test facility, and a mobile nuclear power plant are briefly described. The compressor seal for GCRE-I is a water-buffered, floating-bushing assembly. For the gas turbine test facility the seals are a major problem in the drive end of the turbine-compressor shaft. A face-type seal is used in this area. For the ML-1 unit, a floating-bushing seal similar to that in the Maritime Gas Cooled Reactor is required. (M.C.G.)

19044 (TID-7604(p.107-24)) REVIEW OF INVESTIGATION OF HIGH-SPEED ROTATING-SHAFT SEAL FOR HELIUM. W. A. Glaeser (Battelle Memorial Inst., Columbus, Ohio).

A high-speed shaft seal for a gas-cooled power package reactor using helium as the working fluid was developed. In order to meet stringent leakage and helium-purity requirements, it was decided that the final seal design would have to consist of a combined labyrinth and mechanical face-type seal. The face-seal investigation was divided into two sections: high-speed sliding compatibility of materials and seal dynamics studies using a simulated face-seal configuration and evaluation of commercial face seals. In materials tests, Cr_2C_3 flame plating on tool steel proved to be very compatible with the carbon-graphite. A mathematical relation was derived for leakage between two flat circular plates. High-speed rubbing experiments were conducted in several different gaseous environments. (M.C.G.)

19045 (TID-7604(p.169-81)) CANNED PUMPS FOR MARITIME HELIUM LOOP AND FUTURE SEAL WORK. E. C. Bennett (General Electric Co. Hanford Atomic Products Operations, Richland, Wash.).

The design of the Maritime Gas-Cooled Loop is described. It is operated at a pressure of approximately 200 psi, with a design flow of 450 lb/hr of helium. About 15% of the loop volume is lost each day. The major point of leakage appeared to be at the point where the exhaust valves go into the building exhaust duct. The compressor is described and the seals used on it discussed. (M.C.G.)

19046 (TID-7604(p.183-6)) SEAL PROBLEMS OF THE TURRET REACTOR EQUIPMENT. W. E. Crowe (Los Alamos Scientific Lab., Albuquerque, N. Mex.).

The Turret Reactor Experiment and its objectives are

discussed. The design requires three operating blowers and several spares. As a result of operating a contaminated loop, requirements of virtually no leakage and very high reliability are imposed on all components in the loop. A completely enclosed blower operating on a hydrodynamic gas bearing will probably be used. (M.C.G.)

19047 (TID-7604(p.191-9)) DEVELOPMENT OF SMALL COMPRESSORS FOR GAS-COOLED IN-PILE LOOPS. A. G. Grindell (Oak Ridge National Lab., Tenn.).

Coolant flow requirements for two in-pile loops are given. Two grease-lubricated compressors designed for in-pile operation and two applications of gas-lubricated bearings to compressor design are described. Grease lubrication is preferred to liquid oil lubrication for reasons of mechanical design and system cleanliness. The compressor using gas-lubricated bearings requires no auxiliary cooling at suction temperatures to 800°F. (M.C.G.)

19048 (TID-12330) LEAK-RATE TEST OF FEED-WATER HEATERS. CORE I, SEED 2. Test Results. (Duquesne Light Co., Shippingport, Penna.). First issue, Jan. 31, 1961. 5p. (DLCS-3480201; DLCS-3480202; DLCS-3480203)

The average leak rate between the tubes and shell of the feedwater heaters in the Shippingport Pressurized Water Reactor was measured in three separate experiments and found to be 1.73, 6.47, and 1.82 gpm. (D.L.C.)

19049 (WAPD-BT-22) BETTIS TECHNICAL REVIEW. REACTOR TECHNOLOGY. (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Mar. 1961. Contract AT-11-1-GEN-14 and appropriate NObs-Contracts. 84p.

Developments at the Bettis Laboratory in the area of reactor technology are reported. Seven papers are included for which separate abstracts are prepared. (J.R.D.)

19050 (WAPD-BT-22(p.1-7)) EFFECTIVE ELASTIC CONSTANTS FOR STEAM GENERATOR TUBE SHEETS. W. J. O'Donnell (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

For purposes of analysis perforated materials such as steam generator tube sheets are treated as solid materials having appropriate effective elastic constants ν and E . The values of these effective elastic constants differ for plane stress (in-plane) and bending loads, and are dependent on the direction of the load with respect to the hole pattern as well as the ligament efficiency of the tube sheet. The significance of these variations and their effect on calculated pressure and thermal stresses in the tube sheet and shell of a steam generator are examined. A single set of effective elastic constants applicable to both plane stress and bending loads on the tube sheet is presented. These constants can be used in the entire range of practical steam generator tube sheet dimensions and depend only on the ligament efficiency of the tube sheet. (auth)

19051 (CEA-tr-A-879) BATEAUX-CITERNES DE LA MARINE MARCHANDE, PROPULSES PAR L'ENERGIE ATOMIQUE. (Tankers of the Merchant Marine Propelled by Atomic Energy). J. P. Hulsman. Translated into French by P. Monnard from Zweite Reaktortagung der Studiengesellschaft zur Förderung der Kernenergieverwertung in Schiffbau und Schifffahrt, Kongress bei Hamburg, 25-28 November, 1959. 9p.

Pioneer work done in the Netherlands on the development of nuclear-propelled merchant vessels is briefly reviewed. The proposal to convert a conventional vessel into a nuclear power vessel is discussed. The information to be gained from such a research vessel is tabulated and briefly discussed. (J.S.R.)

19052 NUCLEAR ROCKET STAGES INCREASE SATURN'S PAYLOAD CAPABILITY. Willis Y. Jordan, Jr., Donald R. Saxton, and Paul G. Thomas (NASA, George C. Marshall Space Flight Center, Huntsville, Ala.). *Aero/Space Eng.*, 20: No. 5, 14-15; 38; 42-3(May 1961).

The uses of nuclear rockets in the third stage or in the second and third stages of a Saturn rocket are proposed. Manned lunar orbital and landing missions and deep space missions are described, using chemical boosters and return means. Techniques are described for clustering Saturn rockets for deep space missions. The payload of the nuclear Saturn is about 1.5 to 2.5 times that of a conventional chemical Saturn. (T.F.H.)

19053 GAS-COOLED HIGH-TEMPERATURE REACTORS. Werner Kliefoth. *Atomkernenergie*, 6: 100-3(Mar. 1961). (In German)

A portable power station of 2 Mw on a nuclear basis with a closed gas turbine is being completed. A high-temperature reactor operated with nitrogen as the working gas has already run for 48 hours with a thermal capacity of 1850 kw. Details of the reactor and the gas turbine are given. In the USA a reactor experiment (BORE) is also being carried out as part of a high-temperature reactor system incorporating a closed cycle gas turbine for ship board application (MGCR). Finally, details on the high-temperature reactor system (HTGR) of General Atomic for a 40 Mwe prototype are given, and it is reported that a 300 to 500 Mwe plant is being studied. (auth)

19054 THE CNEN PROGRAMS FOR REACTORS WITH ORGANIC LIQUID AND FOR THE URANIUM-THORIUM CYCLE. F. Ippolito, A. Cacciari, and A. Forcella (CNEN, Rome). *Energia nucleare* (Milan), 8: 196-208(Mar. 1961). (In Italian)

Two major research and development programs—PRO and PCUT—to be carried out by CNEN (Comitato Nazionale per l'Energia Nucleare) are described. The organic reactor program (PRO) involves the realization of a 30 Mwt or organic moderated and cooled reactor, in close cooperation with the U. S. Atomic Energy Commission, and a research and development work. The uranium-thorium cycle program (PCUT) foresees the realization of a uranium-thorium reprocessing pilot plant, in which fuel elements from the Elk River reactor will be treated: its aim is to study the uranium-thorium cycle having in view a power reactor—reprocessing plant integrated complex. (auth)

19055 THE SELNI (ENRICO FERMI) NUCLEAR POWER STATION: PRESENT STATUS OF PLANT DESIGN AND MACHINERY CONSTRUCTION. F. Castelli (SELNI, Milan). *Energia nucleare* (Milan), 8: 261-9(Apr. 1961). (In Italian)

An account is given of the supply and financing contracts of the SELNI (Enrico Fermi) 185 Mw nuclear power plant, which is to be built in Piemonte, near Trino Vercellese. The present status of the designing work is reported. Fuel element type, control rod followers made of fuel material, and the probable control rod programming are described. The present status of the construction work of the reactor vessel and plant machinery is also reported. (auth)

19056 SPECIAL FEATURES AND STATUS OF THE GARIGLIANO NUCLEAR POWER PLANT. M. Covino, R. Lepore (SENN, Rome). *Energia nucleare* (Milan), 8: 276-86(Apr. 1961). (In Italian)

The Garigliano Nuclear Power Plant of SENN, whose construction started late in 1959, is described regarding both work progress and outstanding construction features. Over 60% of the equipment is supplied by Italian industries, such as Terni, SIAC, Ansaldo, Ansaldo S. Giorgio, Dalmine,

or by industries in the European Community, whereas the United States supplies the fuel and the remaining components. (auth)

19057 DRESDEN OPERATION AND LARGE BOILING WATER REACTORS. G. M. Roy (General Electric Co., San Jose, Calif.). *Ing. nucleare*, 4: 13-26(Jan.-Apr. 1961). (In Italian)

The operation of the Dresden nuclear power plant gives technical data and information on the basic problems of boiling water reactors that are still awaiting experimental confirmation. The stability of the system is satisfactory, as far as power oscillations within the core are concerned, under both normal and stress condition. The stability of the system is further controlled by the analysis of transitory phenomena caused by sudden variations in operating conditions. The measuring and controlling of core power prove to be easy. The use of control devices permanently inserted into the core gives good results. The double-cycle, forced circulation system makes possible operation of the reactor under all turbine load conditions, giving regular and easily controllable variations in power output. All necessary operations are carried out to check the efficiency and working of many as yet unused experimental facilities. Experience accumulated in the Dresden operation is extremely valuable for the planning of large boiling water reactors, especially in the field of core voids, of heat transmission under critical flow conditions, and of choice of cycle. A series of basic problems concerning boiling water reactors is examined, namely: corrosion product radioactivity, pressure suppression and internal steam separation. (auth)

19058 OBSERVATIONS ON THE DESIGN AND CONSTRUCTION OF THE N.S. SAVANNAH. J. A. Dodd (U.K.A.E.A. Risley, Lances, Eng.) and S. MacDonald. *J. Brit. Nuclear Energy Conf.*, 6: 95-127(Apr. 1961).

Observations of the design and construction of the N.S. Savannah and the development of nuclear propulsion for merchant ships are outlined. Shipyard practice, ship design, engineering notes, crew training, and health physics are discussed. (N.W.R.)

19059 HPR—A 60 MW NATURAL URANIUM NUCLEAR POWER STATION. R. E. Strickland (London Univ.) and T. J. Fowler. *J. Brit. Nuclear Energy Conf.*, 6: 151-8(Apr. 1961).

A specific generating station design which consists of a single, natural-uranium, graphite-moderated, CO₂-cooled, magnox-type reactor incorporated in a nuclear power station of 60 Mw installed capacity is described. The leading station design parameters are included. The particular features of the station are the comparatively small size of the core, the high operating gas pressure associated with a concrete reactor vessel, and the compact lay-out of the station. It is estimated that the complete cost of the station to the customer, including royalties, will not exceed £ 160/kev, which would make the HPR-type magnox reactor immediately competitive with enriched fuel reactors, even in regions of high capital charges. It is concluded that, contrary to currently expressed opinion, the HPR-type magnox reactor power station of medium output is a commercial proposition of immediate promise; especially in areas remote from large power network centers. (auth)

19060 CRITICAL EXPERIMENT FOR HTRE-III. Bruce W. Link and Richard G. Clark. *Nuclear Energy*, 205-9(May 1961).

The TSM (Tubular Solid Moderator) critical experiment for the HTRE-III reactor is described. The designs of the control system, moderator, diffusion barrier, matrix con-

figurations, and general makeup of the TSM are outlined. The specifications of TSM and HTRE-III are compared. (T.F.H.)

19061 NUCLEAR POWER DEVELOPMENT IN THE UNITED STATES. Frank K. Pittman (U. S. Atomic Energy Commission, Washington, D. C.). Science, 133: 1566-72(May 19, 1961).

A discussion on the nuclear power development in the United States is presented. The main topic is economics. A comparison of the various types of reactors shows the economical advantages and disadvantages of each. Both government and industry hope to achieve economically competitive power by 1968. (N.W.R.)

19062 A DATA PROCESSING MACHINE FOR NUCLEAR POWER REACTOR PROTECTION. J. L. W. Churchill and R. S. Hopkins (Sunvic Controls, Ltd., Harlow, Essex, Eng.). p.92-6 of "Proceedings of the Joint Symposium on Instrumentation & Computation in Process Development and Plant Design." London, The Institution of Chemical Engineers, 1960.

Application of a computer for processing power reactor data to insure safety is discussed. The device receives readings from a detector and records the information on a magnetic drum digital store. The instrument presents the data in the form of a tabulated log sheet on which the numerical values of the activity for every channel in a gas sampling system are recorded. The recordings are made in intervals. Continuous numerical checks are performed on each measurement to ensure that it does not exceed a maximum permitted level, and also to measure the rate of change of the activity level and ensure that this rate lies within prescribed limits. In the event of an abnormal change or rate of change of activity, numerical results are printed giving the time of occurrence and the identification code of the faulty cooling channel and a numerical value of the activity measurement. (N.W.R.)

Production Reactors

19063 (TID-7604(p.159-68)) THE PLUTONIUM-RECYCLE TEST REACTOR GAS LOOP. J. F. Fletcher (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

The Plutonium Recycle Test Reactor gas loop was designed primarily for the study of graphite behavior. The primary coolant gas for the loop will be CO₂, but for some tests CO will be added. A flow diagram of the loop showing the complete circuit for the gas and the main pieces of equipment involved in operation is included. Shaft seals were ruled out by the requirements of the system, as were most conventional types of bearings. The basic construction of the blower is shown. System requirements indicated that only hydrodynamic bearings could be used. (M.C.G.)

Research Reactors

19064 (ANL-6332) PRELIMINARY DESIGN OF A BASIC RADIATION EFFECTS REACTOR (BRER). D. R. MacFarlane, R. R. Rohde, B. Toppel, I. Charak, and H. Unger (Argonne National Lab., Ill.). Mar. 1961. Contract W-31-109-Eng-38. 61p.

The Basic Radiation Effects Reactor (BRER) is a small fast core surrounded by a segmented radial reflector. The NaK-cooled fast core operates at a thermal power of 1 Mw, with all the reactor heat being rejected to the atmosphere through a secondary heat exchange system. The secondary heat exchange system is another NaK loop which dissipates heat to the atmosphere by means of an air-blast cooler. The reactor core is composed of small-diameter rods of

uranium-zirconium alloy, arranged in a close-packed triangular pattern. The maximum core loading is approximately 60 kg of U²³⁵. Reactor control is effected by moving control rods in the reflector region immediately adjacent to the core. Reactor instrumentation and fuel handling are similar to other heterogeneous reactor systems. Relatively large volumes for experiments are available in the large radial reflector surrounding the core. The physics of the BRER system was investigated, using a 15-group set of cross sections, for a series of reflector materials. The materials studied were lead, aluminum, iron, zirconium, depleted uranium, and natural uranium. Based on the criterion of producing two widely spaced and relatively sharply peaked neutron spectra, these preliminary calculations indicate that a major portion of the reflector would be lead, with an aluminum region starting at some intermediate point and extending to the outer edge of the reflector. (auth)

19065 (NP-9674) FINAL HAZARDS SUMMARY REPORT FOR THE UCNC RESEARCH REACTOR. (Union Carbide Nuclear Co. Research Center, Tuxedo, N. Y.). Nov. 1960. 234p.

The reactor is a pool-type research reactor located at Sterling Forest, near Tuxedo, New York. Operation will be at thermal power levels up to 5 Mw with a corresponding average thermal flux of 3.1×10^{13} n/cm²-sec. Forced circulation of light water moderates and cools the reactor. The safety features planned for operation and incorporated in the design of the facilities are reviewed. Natural hazards, minor accidents, maximum start-up accident, credible serious accidents, maximum credible accident, and hypothetical accidents are discussed. (W.D.M.)

19066 (NP-10139) PRELIMINARY DESIGN REPORT FOR THE PURDUE UNIVERSITY REACTOR. (Purdue Univ., Lafayette, Ind. Engineering Experiment Station and Lockheed Nuclear Products, Marietta, Ga.). Apr. 22, 1961. 134p.

The proposed Purdue University Reactor (maximum power level 10 kw) is described and its installation, use, and operation are discussed. A hazards summary and site description are included. (D.L.C.)

19067 100kW "JASON" REACTOR. A. C. Hughes, C. Sanders, and M. G. Tennet (Hawker-Siddeley Nuclear Power Co., Ltd., [Manchester, Lancs, Eng.]). Engineer, 211: 677-82(Apr. 28, 1961).

"Jason" reactors are described in which the power level is increased from the original 10 kw to 100 kw. The problems encountered in making this ten-fold increase in power arise not only in connection with the removal of the extra heat produced but also with a number of effects which, although negligible at 10 kw, become significant at 100 kw. These effects are examined and the steps taken, where necessary, to prevent them from becoming troublesome are described. Attention is paid to the safety of the system. A program of work carried out on the Langley "Jason," which throws considerable light on the behavior of a 100 kw reactor under severe fault conditions, is described here for the first time. (auth)

19068 INITIAL ACTIVITY OF THE ISPRA-1 REACTOR. Mario Motta (Centro di Studi Nucleari, Ispra, Italy). Ing. nucleare, 4: 3-12(Jan.-Apr. 1961). (In Italian)

Experiments performed on the Ispra-1 reactor during startup and first year's operation are described. With a 20% enriched core, the critical mass and other parameters connected with reactor reactivity were determined by subcritical experiments. Results concerning control rod calibrations, temperature coefficients, flux inside core, and uniform poisoning are discussed. Calculations made using two-group theory are in accord with experiment. (auth)

WASTE DISPOSAL AND PROCESSING

19069 (KAPL-1263(Del.)) INVESTIGATION OF ELECTROLYSIS AS A METHOD FOR THE TREATMENT OF RADIOACTIVE NITRIC ACID WASTES. Duane L. Barney (Knolls Atomic Power Lab., Schenectady, N. Y.). Jan. 4, 1955. Decl. with deletions Apr. 28, 1960. Contract W-31-109-eng-52. 21p.

Two possible applications of electrolysis for processing Purex first- and second-cycle wastes were investigated. These applications were copper-catalyzed electrolysis of first- and second-cycle wastes and electrolysis of first- and second-cycle still bottoms. Neither of these appeared to be more satisfactory than distillation when judged solely on the basis of volume reduction. However, they offer a complementary or alternative method of waste disposal. (auth)

19070 (TID-12463) QUARTERLY REPORT NO. 1 [ON WASTE DISPOSAL]. (Brussels. Centre d'Etude de l'Energie Nucleaire). Oct. 28, 1960. Contract EUR/C/3040/60 f. AEC 104/Euratom 167. 23p.

The design and construction of an incinerator for burning radioactive waste are described. Methods for the fixation of radioactive concentrates were investigated and it was concluded that asphalt is a suitable stabilizer. Results are included from a series of elution tests on radioactive slurry-asphalt mixtures in water. Methods were investigated for the removal of radioactive iodine from air. The efficiency of various gas-scrubbing procedures was evaluated. Data are included on the performance of columns packed with caustic lye of soda, special active coal in columns or filters, glass fiber filters, simple scrubbing systems consisting of a tube filled with sorbent material, and spiral glass tubes with copper-treated granular coal used as a sorbent. Investigations were made of the storage of radioactive wastes in the soil. Results are reported from measurements of the velocity of subsoil water using KI^{131} as a tracer. (C.H.)

19071 (TID-12464) PROGRESS REPORT NO. 2 [ON WASTE DISPOSAL.] 3rd Quarter, 1960. (Brussels. Centre d'Etude de l'Energie Nucleaire). AEC 104/Euratom 167. 66p. (Includes original, 43p.).

Progress is reported on the design and construction of an incinerator for radioactive wastes. Methods for the purification of smoke were investigated and the merits of various filtering systems are discussed. The efficiency of various filters for removing gaseous radioiodine from large quantities of air in case of a reactor accident was also investigated. The use of active carbon as an iodine filter and the performance of a recycling system consisting of a tube reactor filled with active carbon are discussed. Results are included from a comparative study of the characteristics of I^{131} as a ground water tracer with and without

the addition of K carrier. Techniques for measuring ground water flow are discussed. The migration of Sr^{89} , Cs^{137} , and Eu^{152} in soil and the effect of pH on retention capacity in water was investigated. (C.H.)

19072 (TID-12465) WASTE DISPOSAL SERVICE. Progress Report No. 3, October, November, December 1960. (Brussels. Centre d'Etude de l'Energie Nucleaire). AEC 104/Euratom 167. 18p.

Progress is reported on the construction of an incinerator for radioactive wastes. The efficiency of various filters for the removal of radioactive iodine was investigated. A study on the fixation of radioactive sludge by mixing with tar was continued. Data are included from a series of incorporation and elution tests. Methods for the fixation of radioactive sludge by mixing with vitrifying agents, methods for the disposal of radioactive wastes in the ground, the possibility of using S^{35} as a tracer for ground water flow, and the migration of radionuclides in soil were investigated. (C.H.)

19073 (WAPD-T-1282) RADIOCHEMICAL STUDIES OF PWR EFFLUENT. J. E. Hudgens (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Mar. 1961. Contract AT-11-1-GEN-14. 14p.

Problems in accurately measuring the radioactivities in waste streams from the Shippingport Pressurized Water Reactor are discussed. The sources of radioisotopes in the coolant are given. Three methods of handling radioactive wastes are used. Evaporation and ion exchangers are used to reduce the volume of waste so that the concentrated residue can be stored or buried. Dilution is used to reduce the concentration in water and air to levels below maximum permissible concentration. Decay of short lived species during temporary storage is also used. Classical chemical separation schemes combined with gamma spectrometry and beta counting allows differentiation of the nuclides making up the more important contributions. A procedure for the separation of radioisotopes of Co, Fe, Mn, Ni, and Cr is given. (M.C.G.)

19074 RADIOACTIVE WASTE DISPOSAL AT THE GEORGIA NUCLEAR LABORATORY. B. M. Bowen, J. M. Selby, and J. H. Edgerton (Lockheed Aircraft Corp., Dawsonville, Ga.). Am. Ind. Hyg. Assoc. J., 22: 119-23 (Apr. 1961).

A system of mixed bed demineralizers is used on the 10 Mw reactor to reduce radioactivity in liquid waste to low levels. Chemical treatment is also provided in the liquid disposal systems. Solid radioactive wastes are buried. Geological and hydrological parameters control selection of areas for infiltration basins, storage, and burial. Sampling and monitoring of both wastes and the environment show that permissible limits of activity have not been exceeded. (auth)

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